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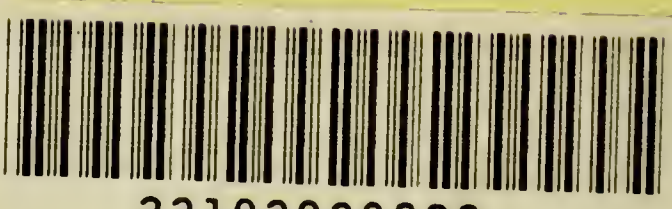
EVOLUTION WITHOUT NATURAL SELECTION

CHARLES DIXON

R. H. PORTER.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EVOLUTION

WITHOUT

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EVOLUTION

WITHOUT

NATURAL SELECTION;

OR,

THE SEGREGATION OF SPECIES

WITHOUT THE AID OF

THE DARWINIAN HYPOTHESIS.

BY

CHARLES DIXON,

AUTHOR OF "RURAL BIRD-LIFE," "THE PHILOSOPHY OF BIRDS' NESTS AND EGGS," ETC. ETC.

LONDON:

R. H. PORTER, 6 TENTERDEN STREET, W.

1885.

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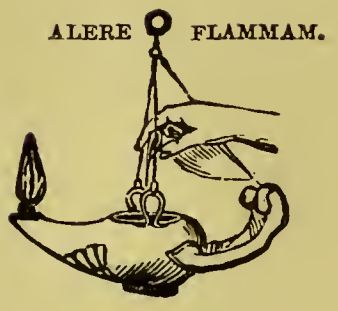

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BY

THE AUTHOR.

PREFACE.

A FEW words are perhaps necessary by way of preface to the following pages. How were they written? why were they written? In the first place, having occasion to thoroughly work out the plumages and distribution of British birds and their allies from an evolutionist's point of view, I was often sorely puzzled in attempting to harmonize the facts before me with Darwin's theory of Natural Selection; and consequently I attempted to explain them by other and, what I believe to be, neglected causes. In the second place, I was led to write up into the present form the result of my investigations and speculations in the belief that they would prove of interest to many naturalists and perhaps, no matter in how humble a way, serve to encourage research and stimulate inquiry in a branch of Biology which is, as yet, almost entirely uninvestigated. If I can convey to the reader even a little of the charm which this subject possesses, I shall be more than repaid.

CHARLES DIXON.

London, Aug. 12, 1885.

INTRODUCTORY.

"Whoever is led to believe that species are mutable will do good service by conscientiously expressing his conviction; for thus only can the load of prejudice by which this subject is overwhelmed be removed."
—DARWIN.

DARWIN'S theory that existing forms of animals and plants have been evolved by means of Natural Selection, or by the preservation of favoured races in the struggle for life, has been almost universally accepted by scientific men as the true solution of that "mystery of mysteries" the origin of species. The great simplicity of the hypothesis in a large measure accounts for its popularity; but even the most sanguine and enthusiastic of its supporters are obliged to admit that there is much that it cannot satisfactorily explain —that it has many weak points which its opponents have not failed to detect and to use to its disadvantage in that conflict of opinion which such a theory must inevitably cause. Darwin, with his accustomed frankness, admits many difficulties; and no doubt his keen perception detected many more which he passed by in silence. The supporters of the theory of Natural Selection have demanded too much from it—have taxed it beyond its strength. Darwin's disciples have been too enthusiastic, too confident, and so blinded by

his grand discoveries, that they seem to have overlooked the important fact that there may be many other causes at work aiding the evolution of new forms of life, in addition to that of the survival of the fittest by Natural Selection; and for these causes they must search if they would solve many difficulties that beset biological investigation. It is only fair to say that Darwin states, in his 'Origin of Species,' that he is "convinced that Natural Selection has been the main, but not the exclusive, means of modification." But in that celebrated book we find the other "means of modification" scarcely ever alluded to; and the very title of the work is sufficient to show that Darwin regarded Natural Selection as by far the most potent, if not the exclusive, agent in the modification of species. Furthermore, he says ('Animals and Plants under Domestication,' ii. p. 192) that "slight individual differences, however, suffice for the work, and are probably the sole differences which are effective in the production of new species." It is high time that Natural Selection took its proper place and yielded up the honours which do not rightfully belong to it; its true value must be ascertained, and the other causes at work in the modification of species must be allowed their proper share of importance: many serious difficulties will then be overcome, and Natural Selection will be freed from much that it is at present asked vainly and most unfairly to explain.

Whilst carefully working at the geographical distribution and the changes and variations of plumage of Palæarctic birds and their allies in various other parts of the world for the past five years, a vast array of facts has been brought to my notice, which appears to suggest some explanation to the many difficulties one meets in attempting to explain the

origin of species—difficulties over which the theory of Natural Selection breaks hopelessly down. How the minute differences which separate so many closely allied species can be of benefit in the struggle for life—how the many fine gradations between species and well-marked races can be of sufficient importance, or be in any way profitable to their possessors, and thus be preserved on the Darwinian hypothesis—has always been to me one of the gravest difficulties of the theory of Natural Selection. The Coal Titmouse (*Parus ater*) is a remarkably good illustration of the difficulty to which I allude. The birds of this somewhat variable species inhabiting the British Islands are distinguished from those of continental Europe by having the slate-grey of the upper parts more or less suffused with brown. This difference was first pointed out by Sharpe and Dresser, who bestowed upon the British form of Coal Tit the name of *P. britannicus*. But the variations of the Coal Tit do not end here. Siberian examples have the upper parts a purer grey, and the underparts a purer white, than West-European examples, and an incipient crest is often observable; whilst in examples from East Siberia, Kamtschatka, and Japan the brown on the flanks extends to the breast and belly. In examples from North China the upper parts are suffused with brown, the underparts are still browner, and the crest is still more developed—differences which have caused the bird to be described as distinct under the name of *P. pekinensis*. When we get into Turkestan we find that the Coal Tit inhabiting that country has the upper parts suffused with brown, and the underparts have become almost uniform brown: this race has been described as *P. rufipectus*. Still further south, in the Caucasus, the difference in colour is about the same,

but the size is slightly larger: to this form the name *P. michalowskii* has been applied. In South-Persian examples the upper parts are even browner than in British, and the flanks are also very brown—differences which have caused the bird to be called *P. phœonotus*; whilst in the Himalayas the birds have the buff underparts still more pronounced, the white cheek-patch is not so pure, and the crest is more developed—differences which have caused this race to be named *P. œmodius*. In the evergreen-oak and cedar forests of Algeria the Coal Titmouse has become so much differentiated (or it would, perhaps, be more correct to say that it is the least changed member of the great Coal-Tit family, seeing that the differences it presents are characters which distinguish the young birds of its European allies) that it has received the name of *P. ledoucii*.

A very similar phenomenon is presented in the Marsh-Titmouse (*P. palustris*); but, in addition to the different shades of colour, the tail varies in shape from being nearly square to very much rounded, the upper parts vary from slate-grey and sandy white to sandy brown, and the flanks from white to brown. This Titmouse has been divided into no less than six species; but in a sufficiently large series the differences intergrade, and no hard-and-fast line can be drawn between either of them. How is it possible to conceive that these slight differences have been produced by Natural Selection? How is it possible to show that in the struggle for life one form of Titmouse gains an advantage over its congeners by the possession of such a trifling difference from them? What conceivable *benefit* is it, for instance, to the British form of Coal Tit to be slightly browner on the upper parts than its congeners in Western

Europe, or greyer than those inhabiting South Persia? I venture to assert that it is no benefit. Natural Selection has not produced this island form of Titmouse by eliminating all birds that did not chance to have a tendency to this peculiarity. Clearly, then, we have here a case where Natural Selection has played no part in the modification of species. But (as I hope presently to clearly demonstrate) this is not a solitary instance; hundreds of species present similar facts.

I.—ISOLATION.

To study the subject more clearly, I purpose to divide the present essay into several parts, each dealing with a considerable mass of facts, which show how species may be modified without any Natural Selective process. In the first place, I will deal with the facts that I have collected which appear to show how ISOLATION has been the agent by means of which many species have been modified.

We must look to other and more universal causes for the origin of many species than to Natural Selection—causes that can work results more rapidly. On the theory of Natural Selection sufficient time (in conjunction with violent changes of the earth's surface) could not have elapsed to form all the wonderful and complex diversity of animal life; but if we take Isolation and other at present disregarded causes into consideration, we see how the changes in organic life can act much quicker, and can almost constantly be in progress. This, I think, is proved by the vast number of occurrences of local forms and imperfectly segregated species at the present day, when never probably in the history of the world were conditions of life more tranquil and geological changes less in progress. Nay, it is even possible that the great amount of variation we now see in so many forms of

organic life is simply the inevitable result of the comparatively tranquil state of the globe—it is even possible that the one fact is but a natural consequence of the other. Natural Selection is probably the most potent agent in the evolution of new species only at such times when the earth is undergoing violent change—as, for instance, during glacial periods, or during great convulsion of the surface by volcanic action, &c. I also think (and all the evidence I am about to bring forward proves its correctness) that during the comparatively calm periods of the earth's history—the lulls in the great convulsive strife—many species are evolved purely by Isolation, and by many attendant minor causes, as overcrowding and its consequent emigration, &c. Comparatively uniform conditions of life are, in my opinion, aids to variation, and consequently to the establishment of many local forms or incipient species. At the present day we have countless instances of incipient species in every form of life, both animal and vegetable, which are undoubtedly produced without the interfence of any Natural Selective process ; for the conditions of life of many incipient species and the parent forms are at the present time practically the same throughout the area of their distribution, or only slightly different from climatic or other local causes. We can conceive how, as soon as violent changes once more pervade the world, the struggle for life will be infinitely greater than it is now. Then species will be matched against species, race against parent form, or race against race ; all Nature will be thrown into a kind of chaos : and then Natural Selection will adjust the disordered balance—the forms best fitted to cope with the changed conditions live, those not so constituted die ; the law of the survival of the fittest will

inexorably perform its task, and gradually Nature will settle down into her accustomed course, furnished with those forms of life best adapted to the changed conditions of their surroundings. Again, Isolation and its constant attendant, Variation, work hand in hand together—incipient forms, imperfectly segregated species, branch off from the then representative or parental species of the world after her convulsive or glacial change, and similar phenomena to those now before us at the present day have been or will be presented as the cycle of mighty and violent changes are relieved by intervals of tranquillity. We can understand how Natural Selection can probably assist in giving to the butterfly its protective hues, or to the tiger its stripes, and to the leopard its spots; but no amount of Natural Selection can explain the infinite gradations between so many species, or the shades of colour which denote so many closely allied but perfectly distinct forms of animal life. How, then, have these marked characteristics been produced?

Let us glance at a few striking instances that plainly show how Isolation has been the means in many cases of modifying species. No better examples can be found than amongst the great cosmopolitan subfamily of the Thrushes (Turdinæ). Take, for instance, the species and races of the genus *Catharus*, or Thrush-Robins—a small group of birds confined to the mountains of South Mexico and Central America, and the Andes as far south as Bolivia. These birds frequent the forests on the mountain-sides, never descending to the lowlands. The genus contains twelve recognized species; but some of them have evidently only quite recently become differentiated, and the characters on which their specific rank is based are so slight that, were it not for their

geographical areas being different, no reasonable excuse could be found for separating them. Many of the species, however, though obviously most closely allied, are separated from each other just as completely as non-migratory species on many islands, the birds on one chain of mountains being completely isolated from the nearly allied species on another chain. They are all resident birds, so far as is known, and never descend from their own particular zone to the lowlands, where they might interbreed, and thus prevent by intermarriage any slight difference from becoming constant. How have the slight differences which mark many species in this group arisen? Let us go back to the time when the parent species inhabited the lowlands: we can imagine how the climate changed, or some cause arose which drove the species to the mountains, some birds up one, some up another. Not being migratory, or perhaps gradually becoming resident in their highland haunts through favourable conditions of life, we can understand how Isolation would soon do its work—changes of colour, perhaps changes of structure (one possibly involving the other) arise, and new species are eventually evolved. We can then understand how one form acquires a slate-grey mantle, another a russet one, another a chestnut head, or others a black or grey head—the accidental variations or, perhaps, in some cases, reversions in any one direction being preserved simply because they were isolated.

Take, for instance, *Catharus griseiceps* and *C. phæopleurus*, only distinguished by the shade of colour on the back. In the former species it is russet-brown, in the latter it is olive-brown. *C. griseiceps* has only been obtained on the highlands of Panama, whilst *C. phæopleurus* is apparently

confined to the mountain-forests of Antioquia in Colombia. Undoubtedly these two species at no very remote period were one. Circumstances arose that divided the area of its distribution, sending one portion up the highlands of Panama, the other up those of Colombia. Our single species is now isolated into two colonies: perhaps *C. griseiceps* was exposed to a more pluvial climate, causing it to gradually develop a russet-brown back. The two colonies never intermarried; the slight differences would therefore soon become constant by Isolation, and finally the result is as we see it at the present time—two nearly allied, but apparently perfectly distinct, species inhabiting different areas of distribution. No Natural Selection could possibly have been at work in such a case; for it could have served no beneficial purpose. It was no *advantage* for either colony to possess those differences that have finally become constant characters; they gave their fortunate possessors no favour in the struggle for life—a russet back was no more advantage to its possessor than an olive back, though both have been preserved, not by the survival of the fittest, but simply by Isolation.

Let us now glance at a few of the Pacific-Island Thrushes. Not counting *Merula albiceps* from Formosa, and *M. javanica* from Java, Sumatra, Borneo, and Timor, which can scarcely be regarded as belonging to this little group of Oceanic Thrushes, we have ten species distributed throughout the Pacific, all obviously closely, some very closely, allied, and evidently all descendants from one or two common ancestors at no very remote period. Of these ten species no less than five are almost exclusively distinguished by the colour of the head and neck, which is in violent contrast to the rest of the

plumage—*pattern* of colour which can only show community of origin. Three of these species are nearly uniform black in colour; but one of them, *M. pritzbueri*, has the head and neck creamy grey and is confined to Lifu, one of the Loyalty group of islands; another, *M. bicolor*, inhabits Kandavu, one of the Fiji Islands, and has the head and neck orange-buff; whilst the third, *M. tempesti*, is distinguished by having those parts brownish grey, and is apparently confined to Taviuni, another island in the Fiji group. The remaining two species are almost uniform black, with the exception that the under tail-coverts have pale shaft-lines and tips; but this may be a mark of immaturity. One of these two species, *M. albifrons*, is distinguished by its white head and neck, and is confined to Eromanga, an island of the New Hebrides group; whilst *M. poliocephala*, having the head and neck brownish grey, inhabits Norfolk Island, between New Caledonia and New Zealand. Of the remaining five species, one, *M. xanthopus*, inhabits New Caledonia, and is almost uniform dark brown; another, *M. vinitincta*, is found on Lord Howe's Island, and only differs from the preceding species in being lighter in colour and slightly smaller in size. A third, *M. vitiensis*, is confined to Viti Levu, one of the Fiji group, and is chiefly distinguished by having the underparts below the breast rich deep chestnut; *M. samoensis* is confined to the Samoa Islands, and is characterized by its uniform dull black plumage; and, lastly, *M. mareensis*, from Maré, one of the Loyalty Islands, is almost uniform dark brown, with black wings and with chestnut-brown shafts and tips to the under tail-coverts. What do we infer from these interesting facts? Probably most, if not all, of the island homes of these Thrushes are of volcanic origin. Large islands have perhaps been split up

into several smaller ones by volcanic action, and by this means the individuals of one or two parent species have been isolated, where in course of time they have become differentiated. Conditions of life throughout this ocean must be very uniform; the birds on one island would be exposed to practically the same struggle for existence as their congeners on another island, so that any of the slight differences which the several species now present could never have been preserved by any *Selective* process. The shade of colour of the head could not possibly be of any benefit in the struggle for life, or have determined which individuals should live and which should die; streaked under tail-coverts could not be of any advantage over plain ones, and thus be preserved by Natural Selection weeding out all individuals that did not chance to possess them, seeing that birds with both kinds inhabit localities not very far apart.

Or we can suppose that at some remote time the islands of the Pacific were peopled by emigrant birds driven from northern haunts by a glacial period. We can understand how one or two species swept down and located themselves on the islands of the Pacific. Some gained places where they could live and multiply; others were probably cast on unsuitable islands, where they eventually died out. No cause for any migration arose, the birds on one island did not visit those on another island. In time Isolation and Variation would gradually split up the one or two parent species into several forms, peculiar to certain islands; and the results are as we now see them—almost every island that can support a Thrush having a species peculiar to it, differing in some cases but very slightly from the species on neighbouring islands.

How, then, is it possible to make Natural Selection responsible for the evolution of these island Thrushes? Their conditions of life are similar; there is no reason why one species should be better fitted to cope with its surroundings. We have no evidence to show that any competition between species took place; no selection of individuals was required; still a change occurred—a change that eventually slowly but surely segregated a species into several representative forms. How are these species evolved? Simply by individuals becoming isolated on certain islands, where no interbreeding could take place, and where the variations any of those individuals might chance to present were preserved, not by the survival of the fittest, but by their isolation, and finally became fixed characters. The case of these Pacific-Island Thrushes is only one amongst thousands of similar cases where islands possess peculiar resident species, nearly allied in most instances to species on neighbouring islands or continents, and which, there can be no reasonable doubt, have become modified by their isolation.

Further, it seems that when these Thrushes were driven down to the Pacific some were isolated in India and Formosa. Thus we have in India *M. castanea*, a species nearly uniform rich chestnut, with black wings and tail, but with the head and neck pale grey. In Formosa, as previously stated, *M. albiceps* is found, a species with a white head and neck, nearly black upper parts and chestnut lower parts. Both these species are obviously very closely allied to many of the Pacific-Island Thrushes, and owe their specific distinctness to their isolation. In the same way we can understand how it was, when the common ancestor of *M. javanica* and *M. vitiensis* was driven southwards, some of the individuals of that

parent species lingered in Java, Sumatra, Borneo, and Timor, and possibly other islands in the Malay archipelago, whilst others sped onwards to the Fiji Islands. The descendants of the birds that were isolated in the northern islands are known as *M. javanica*—a species almost uniform brown, except below the breast, which is rich chestnut, and the under tail-coverts, which have broad pale shaft-lines and tips. The birds in the southern islands are known as *M. vitiensis*, closely resembling their northern cousins, but the brown on the head, neck, and breast is paler.

We have seen how species can be modified and local forms evolved by Isolation on islands and mountains; now let us see how the same great universal law can work on continents. A most interesting instance is to be found in the common House-Martin (*Hirundo urbica*) and its allies. It is rather doubtful whether the little English House-Martin, with which we are all so familiar, occurs east of the Ural Mountains; but from the valley of the Yenesay eastwards to the Pacific a nearly allied but perfectly distinct species, *H. lagopoda*, is found. It only differs from the Western species in having the longest upper tail-coverts white instead of black, and in having a shorter and squarer tail. Besides these, we have another Martin, *H. dasypus*, confined during the breeding-season to Japan, which is rather larger than our bird, and has the chin, just at the base of the lower mandible, black—a character only perceptible on close examination. It is also characterized by its slightly forked tail and black longest upper tail-coverts. Another ally of our Martin, *H. cashmirensis*, is confined to the Himalayas, and is a somewhat smaller bird, also with the slightly forked tail of *H. lagopoda*, but the black longest upper tail-coverts of the

English Martin. We have here four species of Martin, all very closely allied, yet presenting constant distinguishing characters. It is, however, impossible to conceive how the trivial differences which characterize them have been acquired by Natural Selection or the survival of the fittest. A minute black spot on the chin, a more or less forked tail, or black longest upper tail-coverts could not possibly have been of sufficient benefit or advantage, in the several localities to which the birds possessing them are peculiar, as to ensure the elimination by Natural Selection of all individuals that did not chance to develop them. There can be scarcely any doubt that Isolation again has been the means of evolving these species. At some remote period all these Martins were the same species, with a continuous area of distribution; but circumstances arose that eventually isolated the individuals of this species in four districts—in Japan, the Himalayas, East Siberia, and Europe. Not being able to interbreed, these four colonies of Martins gradually developed the slight specific characters which they now possess. The Common Swallow (*H. domestica*) and its numerous allies present very similar facts; and there can be little doubt that all the representative species of this bird are descendants from a common ancestor, not by Natural Selection, but by Isolation preserving the several variations, which have finally become fixed and definite characters.

The Dipper is another remarkable instance of how a species can be modified into several representative forms by Isolation. The Dipper throughout its wide area of distribution is practically a sedentary species, even the birds inhabiting one river-valley comparatively seldom visiting and interbreeding with the birds of the adjoining valleys, so that even

in England slight differences are easily detected by an experienced eye amongst the birds from certain districts. The Irish Dipper is said to be slightly different from the English one. Confining our observations to the West Palæarctic Dippers, we find the following interesting facts. Beginning ith our own islands, we find that the Dippers (*Cinclus aquaticus britannicus*) are slightly different from those on the continent, having the chestnut on the lower parts developed to its greatest extent, and the head and nape very dark brown. Away northwards in Scandinavia the Dipper (*C. melanogaster*) inhabiting the wild mountain-streams of that rugged country has no trace of chestnut in its plumage, that colour being replaced by nearly black. On the streams of the Vosges Mountains and the Pyrenees another form of Dipper is found, intermediate in colour between the typical British form and *C. albicollis*, inhabiting the countries bordering the Mediterranean Sea. This latter species is found in the mountains of Spain, Italy, Greece, and Algeria, and is distinguished by its much paler upper parts. Were we to follow the Dipper into Asia similar facts would be presented; other forms occur in several districts of that enormous continent; but sufficient has been gathered for our purpose. From its habits, and from the nature of the localities it frequents, the Dipper is a bird peculiarly liable to those modifications in colour which Isolation so often produces. But in many localities the ranges of some of these Dippers coalesce, and then interbreeding takes place, so that in a large series no hard-and-fast line can be drawn between them. These extreme forms, however, rarely, if ever intermarry; but the individuals in one valley sometimes mate with their congeners in an adjoining valley, and they in their

turn with their neighbours in the next. This interbreeding is most probably the reason why each of these races of Dipper has not become completely differentiated. The differences Isolation produces are being constantly nullified by the intermarriage of individuals; this free intercrossing keeps in check, by blending together, slight differences in colour which may arise. If from any cause this interbreeding should cease, Isolation would, in the course of time, effectually complete the work it has commenced, and slowly but surely evolve these geographical races into species. Climate may have some influence on the colour of the plumage of these Dippers, developing the chestnut in warm and wet localities, the black in cold and the pale grey in dry ones; but it seems more probable that Isolation is the most important agent in the work of differentiation. We know that other species inhabit the entire area occupied by the Dipper, and are exposed to precisely the same climatic changes, yet do not present any noticeable difference in colour, probably because their area is continuous and they intermarry throughout that area. That climate does modify species in a most remarkable manner, I am not for one moment going to deny: indeed I hope presently to show that it is one of the most important agents in the modification of species; but in the case of the Dippers it does not seem probable. We have here another convincing proof that Natural Selection has not been the agent of modification. Such slight differences could not possibly be of any benefit to the birds acquiring them. These variations were not preserved by the survival of the fittest, but purely by Isolation. The *cause* of the variation is, after all, of only minor importance in such a case.

The Common Wren (*Troglodytes parvulus*) is a very similar instance to the foregoing. This little bird in one of its numerous forms is found in the temperate parts of the Palæarctic, North Oriental, and Nearctic Regions. There can be little doubt that formerly, when the Arctic regions were much warmer than they are now, the Wren was circumpolar. Now its range does not extend anywhere above the Arctic circle. Throughout its extensive distribution it has become isolated in some localities, and is exposed to considerable differences of climate, with the result that ornithologists recognize upwards of a dozen races or species. A glance at one or two of these will be sufficient for our purpose. The Wren found in the British Islands is similar to that inhabiting the greater part of continental Europe; but in St. Kilda, as I had the good fortune to ascertain last year, there is another very distinct race, distinguished by its much greyer colour and barred upper parts. It is known as *T. hirtensis*. In the Faroes and Iceland the Wren (*T. borealis*) differs from that in the British Islands in being darker on the upper parts, the underparts are more strongly barred, and the beak is longer. From its habit of perching on rocks rather than on trees and bushes, its feet, like those of the St.-Kilda Wren, are much stouter. These Wrens are not migratory; the differences they present are so trifling that it is impossible to conceive how they could be of any benefit in the struggle for life, and thus be preserved by Natural Selection. Again we have a case where Isolation has produced the differences above alluded to. We can imagine how, as the arctic cold increased, the Wrens were driven southwards from their circumpolar area: some tarried in the comparatively mild climate of Iceland and the Faroes, others sped onwards

to St. Kilda, whilst the majority found refuge in Southern Europe and Asia and in Japan. In the western hemisphere the events were similar: some remained on the islands in Behring's Sea, some went down the American continent east of the Rocky Mountains, others west of that mighty chain. What is the result? Wherever the peculiarities of the district isolated them from their companions, either on islands or by mountains and deserts, a local race has been established. In some cases climatic influences have slightly changed the hue of the feathers, but in all Isolation has been the primary cause of the differentiation of these species. The Shore-Larks, the Grey Shrikes, Kingfishers, Starlings, and many other Palæarctic birds might be brought forward as further proof of the importance of Isolation in the modification of species.

On the American continent the Rocky Mountains have been the indirect means of modifying many species. If a bird is distributed over the entire North-American continent, and does not breed sufficiently far north for the area of its distribution to escape these mountains, we expect to find, and in most cases *do* find, an eastern and a western form, divided from each other by this mighty barrier. The isolation of these forms probably took place in the following manner:—During an interglacial period, when the northern portions of the American continent were much warmer than they are now, many species bred in those high latitudes which have since been compelled to retire to more southern and milder quarters, as the cold of a coming glacial period increased. The majority would naturally retire southwards into temperate America east of the Rocky Mountains; but many would take a more westerly course

towards California, and thus become isolated from the other members of the species. Variations (in many cases caused, no doubt, by the difference of climate) would eventually become constant through the absence of any interbreeding, and finally representative forms would be established. These forms are evolved, not through the competition of race against race or variety against variety, and the consequent survival of the fittest, but simply through being isolated. As an example we can take the Canada Grouse (*Tetrao canadensis*). The typical form of this species inhabits North America east of the Rocky Mountains; but on the Northern Pacific slopes of these mountains (that is to say, west of them) a representative species is found, *T. canadensis-franklini*, which principally differs from its eastern ally in having the upper tail-coverts broadly tipped with pure white, instead of being narrowly tipped with deep ash-colour. A very similar instance is to be found in the American Robin (*Turdus migratorius*) and its Californian representative, *T. confinis*. A perusal of Baird, Brewer, and Ridgway's elaborate work on North-American birds (the subject being studied from an evolutionary point of view) will reveal numerous cases where the Rocky Mountains, and not Natural Selection, have been the agent by means of which species have been modified.

Let us now glance at a few instances of a slightly different character, where Isolation has acted on what we might term a much grander and wider scale, although the ultimate results are very similar.

Ages ago the Circumpolar Region, instead of being, as it now is, little more than an icy waste with a short fleeting summer, was a fertile district covered with forests of semi-tropical verdure, with tree-ferns waving in the gentle polar

breeze, with huge camphor-trees, chestnuts, magnolias, walnuts, and many others flourishing in a climate proportionately suitable to the growth of such vegetation. This fertile belt of forest-country extended in an almost continuous chain round the north polar region of to-day; Arctic America and Arctic Euro-Asia were, zoologically speaking, connected by this fertile land. Giant animals roamed through the forests, Ducks and other aquatic fowl swam upon the waters, whilst Sandpipers tripped about the strands; the trees were full of Passerine songsters, and the ocean rocks were tenanted by sea-birds. All these species were probably residents and dwelt in one continuous area, just as the several species inhabiting America and Asia do on those continents at the present time. But this fair picture must pass away; like the gorgeous glittering transformation-scene it changes: an icy mantle crept slowly from the pole and covered this fertile land; the huge trees and shrubs were embraced in its grasp and became fossilized; many large mammals shared a similar fate. The birds, and such animals as could emigrate, retreated before this ever-advancing phalanx of ice into the milder regions of Africa and Southern Asia and America. Some individuals took a western course, others an eastern; and in this way many species were separated into two enormous colonies, becoming completely isolated. What are the results? Probably few of the species then living in the circumpolar region survive at the present day. Many of them became extinct; many of them have been segregated into two or more forms, as I hope presently to show; and in all these latter it is impossible to account for the modification which has taken place by any selective process. As soon as interbreeding was prevented by the isolation of the

individuals, slight variations in different directions would be preserved, and in the course of time become constant. To Isolation therefore, and not to Natural Selection, we must look for the cause of the evolution of these geographical races or representative species.

Let us glance at a few instances. The Goosander of the Palæarctic Region (*Mergus merganser*) is represented in the Nearctic Region by a very closely-allied form, *M. americanus*, only differing in having the black bases of the wing-coverts exposed so as to form a narrow bar halfway across the wing. The Pochard (*Fuligula ferina*) is replaced on the American continent by the Red-headed Duck (*F. americana*), which principally differs from its Old-World ally in wanting the black at the base of the bill, in the greyer colour of the back, and in the unvermiculated white belly. The Eider Duck (*Somateria mollissima*) furnishes another instance. The typical form of this bird breeds from Nova Zembla to Baffin's Bay; but on the American coast of the North Pacific it is replaced by a nearly-allied species, *S. v-nigrum*, only differing from it in having a black **V**-shaped mark on the throat. The Scoters are another interesting instance. The Common Scoter (*Œdemia nigra*) breeds from Iceland to the Taimur Peninsula in North Siberia. It is replaced in the Nearctic Region by the American Scoter (*Œ. americana*), which breeds from the Kurile Islands, in the North Pacific, as far east as Hudson's Bay. The difference between these two species is very slight, the tubercle at the base of the bill being black in the Palæarctic and bright orange in the Nearctic species. Numerous other instances might be quoted, especially from amongst the Scolopacidæ and the Charadriidæ, in which two great families almost every non-circumpolar Palæarctic

species is represented in the Nearctic Region by closely allied forms, obviously descended at no very remote period from a common ancestor. These are profoundly interesting facts, illustrating, as they do, the great importance of Isolation in the modification of species, and, I think, satisfactorily account for the existence of these closely-allied species and representative forms when the Darwinian hypothesis has utterly failed to do so.

It seems to me very probable that the reason Nearctic land-birds are so much more distantly allied to Palæarctic land-birds than the water-birds of these two regions are to each other is because they only inhabit forest districts. Water-birds breed much further north—as a rule, beyond the limit of the growth of trees, on the open tundras and the shores of the Polar Sea, where the variations Isolation produces are being constantly nullified by the interbreeding of these representative forms*. But with land-birds it is different. When once they were driven southwards from the polar forests, there of necessity they had to remain, their limits being marked out by the line of forest-growth, which

* It may be asked why such wide-ranging birds as the Sanderling and the Knot, subject to almost every diversity of climate, do not present any differences. The answer is a simple one. Though the *winter range* of these birds may extend almost throughout the temperate and tropical regions of the world, their *breeding-area* is remarkably restricted, being confined to the North Polar Region, where little or no Isolation is possible, and where it is consequently continuous. Local races are soon established even in a very restricted area if its physical conditions are favourable to Isolation; but a species may be cosmopolitan, and yet present no constant variation if its breeding-area is continuous. This fact is being constantly overlooked by naturalists, and yet it is one which should ever be borne in mind by students of geographical zoology.

now nowhere extends sufficiently far north to make the area again continuous. The few Passerine birds that breed in the high north above forest-growth are circumpolar, and do not present any constant geographical variation. We do not find a Palæarctic and a Nearctic race of Wheatear, or an American and a Euro-Asian Snow-Bunting, Raven, or Shore-Lark, simply because the breeding-area of these species is continuous. But we find an American Goshawk and a Palæarctic Goshawk, simply because this bird does not breed above forest-growth and is completely isolated. In the same way, America has no Redwings or Fieldfares; not a single Thrush is common to both regions, because the breeding-areas of these birds is bounded by forest-growth and therefore never impinges. In water-birds, where the differences have become constant between Palæarctic and Nearctic species, the characters on which their distinction rests are only *specific*; but with land-birds they are in most cases *generic*, or of such importance as to make them of a *subfamily* or even of a *family* value. Thus in America we have no Sturnidæ, in the Palæarctic Region we have no Icteridæ. The birds that hopped about the now fossilized branches of those Miocene polar forests were most probably the common ancestors of nearly all the northern types of Passerine birds of the Palæarctic and Nearctic Regions of the present day. We do not want to assume the past existence of a great Atlantic continent, or a land-communication between Asia and America by way of Alaska, to explain the similarity of type that exists between the Miocene flora of Europe and the present flora of Eastern North America, or, in the same way, the similarity between the existing faunas of the two continents. We can explain it by the presence of that now ice-bound polar conti-

nent—the grand home in which the common ancestors of these Nearctic and Palæarctic types existed, and from which their present descendants have been slowly evolved by Isolation and other causes. But we cannot stay here: analogy demands that we look back to a remoter past, even to the very dawn of life itself. It irresistibly forces us to the conclusion that the earliest forms of life originated in the Polar regions, and that from those two points all living forms have been dispersed. Glacial epochs have been the grand causes of dispersal; and as the equatorial portions of the globe slowly cooled, the grand march of animal and vegetable life advanced and peopled them. Most of the species in these regions have long ago lost all trace of their Polar origin; but many great groups, which have been dispersed more recently from these centres, are surrounded by the still legible evidence of their northern or southern home. Geology, in temperate climes, has told us much of the earlier history of life; but what profoundly important information could it reveal if it were possible to read the records which now lie buried under those mighty caps of eternal ice and snow in the regions round the Poles!

Nearly all the birds of the Nearctic and Palæarctic Regions are migratory—a most interesting fact, which confirms us in the theory that the species inhabiting these two tracts originally came from the Circumpolar Region, the habit of migration being slowly acquired as the climate changed and the cold period came on. The greater number of the water-birds, after escaping the icy terrors of this northern land, return unerringly in spring to their old quarters, or as near to them as they can, because the haunts to which they resort are of the same character now as when they frequented them

ages ago. But with land-birds the case is different; the extent of their area is marked out by the growth of trees.

The Procellariidæ furnish us with several other interesting instances illustrating the mode by which many oceanic species have been modified. The Stormy Petrel (*Procellaria pelagica*) is confined to the Atlantic Ocean; but in the Pacific Ocean, on the Galapagos Islands, a very nearly allied species is found (*P. tethys*), which differs from the typical form in having no dark tips to the upper tail-coverts, and in having no white tips to the axillaries and under wing-coverts, whilst the tail is considerably forked. The typical Fulmar (*Fulmarus glacialis*) is probably confined to the Atlantic Ocean; but in the North Pacific its place is taken by two doubtfully distinct races (*F. rodgersi* and *F. glupischa*), which differ in being on an average darker in colour, with a paler bill. The Great Shearwater (*Puffinus major*) of the Atlantic is represented on the Asiatic coasts of the Pacific by *P. leucomelas*, differing principally in having the pale margins to the feathers of the back nearly white, and with more white on the upper tail-coverts; whilst on the American coasts of that ocean it is represented by *P. creatopus*, which chiefly differs in having no white on the upper tail-coverts. The Manx Shearwater (*P. anglorum*) is another well-known Atlantic species, which is represented in the Pacific by the Black-vented Shearwater (*P. opisthomelas*); whilst in the Southern and tropical seas these forms are represented by *P. obscurus* and *P. assimilis*, both of which are distinguished by having the crown of the head not extending below the eye, and the latter is further characterized by its small size. The inference to be drawn from the above series of facts is that the common ancestors of these species were circumpolar during the time

when the northern seas were much warmer than they are now, and that when the climate changed through the influence of a glacial period, and the then circumpolar Stormy Petrel, Fulmar, Great Shearwater, and Manx Shearwater were driven southwards, some of the individuals of each species were isolated in the Atlantic and others in the Pacific. The absence of reciprocal breeding preserved the variations in different directions which arose; and the result is that Atlantic and Pacific races or representative species of each have been evolved. Isolation alone explains the modification which has taken place; for the distinctive characters are of such a slight nature that it is impossible to conceive that they have been preserved by Natural Selection. In the Atlantic Ocean alone a considerable amount of modification has taken place; for in the Mediterranean the Manx Shearwater is represented by a form known as *P. yelkouan*, and the Great Shearwater appears to have become modified by Isolation in that sea into the species known as *P. kuhli*. Not a single species of North-Atlantic Petrel survives at the present day in the North Pacific, with the exception, perhaps, of the Fork-tailed Petrel (*Procellaria leachii*), whose range, as at present known, is absolutely discontinuous; but further research may afford an explanation to the apparent anomaly.

We can picture to ourselves the time, in the far distant future, when the North Polar Region will become once more inhabited by those birds and animals, or their modified descendants, which frequented that region in the remote past. We can imagine how the forest-birds will follow the slow growth of trees, and other birds push on in each successive age, nearer and nearer to the pole, until that region once more abounds with life. Nearctic and Palæ-

arctic, Atlantic and Pacific types will once more intermingle, some probably encroach on the ground of the others and exterminate and replace them. The ensuing glacial periods will just as surely drive them south again; the icy mantle will entomb this fertile land once more: in their grand march southwards these animals will again become isolated; new races, new representative species will be established; old forms will pass away, as the grand cycle of interesting phenomena is repeated.

Let us now glance at another result of Isolation with which every student of Palæarctic birds is familiar; and that is the occurrence of eastern and western forms. We have already seen similar phenomena in the Nearctic Region, but the results have been brought about in a different manner. There can be no doubt that the physical aspect of the two regions is the cause of this. In the Nearctic Region the mountains run in a north to south direction, from the arctic regions to the tropics; in the Palæarctic Region the ranges run from east to west. When the birds of the Circumpolar Region were driven southwards we know that many individuals of certain species were isolated on the west of the Rocky Mountains, and others on the east of that chain, with the result that numerous local forms have been established amongst those birds that do not breed in the high north. Many of the birds that peopled the Palæarctic Region were driven southwards into Africa and Southern Asia—into two enormous colonies. During the time of their isolation in these two areas we can understand how slight variations in many species gradually became constant characters, and eastern and western races were evolved. As the cold in the north slowly passed away, the

birds in Africa gradually returned north again towards their old haunts; the birds in Southern Asia pursued a similar course. So attached, however, do they appear to have become to what we many now fairly call their winter-quarters, that the individuals of a species breeding in North Europe unerringly retreat to Africa for the winter; whilst those which breed in North Siberia seek winter-quarters in India, China, the Malay archipelago, and Australia. This is conclusively proved by the fact that what few species have extended their breeding-range from Africa to East Siberia return to their African winter haunts, and never by any strange chance visit China or India, although these countries are so much nearer and equally well suited to their requirements. Thus the Red-footed Falcon (*Falco vespertinus*) is known to breed as far east as the valley of the Yenesay and to return to Africa to winter; whilst the little Willow-Wrens and Sedge-Warblers, that summer as far east as that Siberian valley, return to Africa for the cold season! The Little Gull (*Larus minutus*) breeds as far east as the Sea of Ochotsk, but returns to the extreme south-west of Asia and to Africa to winter, instead of seeking the Chinese coasts directly south of its summer-quarters, and only about a fourth of the distance! In the same way the Rustic Buntings (*Emberiza rustica*) (an Asiatic species), which breed as far west as Scandinavia, migrate to India and China to winter. The Arctic Willow-Wren (*Phylloscopus borealis*) breeds as far west as Finmark, but winters in the Malay archipelago and Burma; whilst the Siberian Pipit (*Anthus gustavi*) is known to breed as far west as the valley of the Petchora, but retires to South-eastern Asia to winter. Another most remarkable instance is furnished by the Arctic Tern (*Sterna*

arctica). This bird must be regarded as an Atlantic-Ocean species, but has extended its breeding-range in the east down the great river-valleys of Siberia to the Arctic Ocean, and in the west along the lakes of Arctic America, until it becomes circumpolar, the two streams of migrants meeting on the shores of Behring Sea, where they breed in some abundance. But the most curious part remains to be told. The birds that undoubtedly breed on the confines of the North Pacific Ocean never retire to that ocean to winter, but seek the Atlantic Ocean for that purpose, crossing thousands of miles of land and water so that they may reach the quarters which are really their true home and the centre of their dispersal. Even in the British Islands several species have gradually extended their range within the memory of living man, and are still doing so at the present time. As tree-planting takes place, such birds as the Rook, the Missel-Thrush, and the Black Grouse spread and make new breeding-grounds in the districts which have undergone the change. The Rook is one of the most remarkable instances, for it extended its colonies to the Western Islands of Scotland as soon as the plantations were sufficiently large to support its bulky nests. What is going on in our islands now on such a trifling scale and under artificial conditions has also been going on in vast districts as natural influences have changed the face of the country and enabled species to spread far and wide from certain centres of distribution.

We can thus understand how, when Polar species were driven southwards, many of them were separated into two colonies, and an eastern and a western form or species produced by their being isolated. But, as most ornithologists know, many of these eastern and western races are only sub-

specifically distinct, and the differences the two extremes present are completely bridged over by intermediate forms in intervening localities. These are produced by interbreeding. As the two isolated colonies of many of these species began to move north again, they multiplied, gradually spread east and west, and again came into contact with each other in Central Siberia—peculiarities of dispersal which, I think, are proved by the remarkable instances of migration given above. Many species had, however, become so much differentiated during their isolated sojourn that they either lost the power or the inclination to interbreed, and consequently we find no intermediate forms between several closely allied eastern and western species; but others had not reached that standard of modification which determines a species, and consequently, as soon as their areas of distribution again became continuous, interbreeding took place on an extensive scale wherever the ranges of the two forms coalesced. The extreme forms, however, seldom or never interbreed, and if they did so, their offspring would probably not be fertile: the birds inhabiting Sweden never pair with those in East Siberia; but in the intervening country the birds in one district pair on either side with their near neighbours, and consequently every intermediate form between the two extremes is to be found.

Let us glance at a few instances by way of illustrating the foregoing remarks. Perhaps one of the best examples of an eastern and a western form is to be found in the Curlew and the Whimbrel, both well-known British birds. The former may be regarded as a Palæarctic species; but in the east of that large region the Curlews are distinguished by their white unspotted lower back and almost uniform white

axillaries. They are known as *Numenius lineatus*. The Whimbrel has an equally extensive range in the Palæarctic Region, but in the east has become slightly modified, being there represented by a closely allied form, *N. variegatus*. Curiously enough, the differences which characterize the eastern and western races of the Curlew have been reversed in the Whimbrel, and the eastern form of that bird is distinguished by its streaked and spotted lower back. It is impossible to account for the modifications which these two species have undergone by any natural selective process. It would be an impossible task to show how the Curlews in the east have gained an advantage by losing the spots on that part of their plumage, or that the Whimbrels have gained a similar advantage by acquiring or retaining them. The habits of the two birds are precisely the same; what would be of advantage to one species would be equally so to the other. It should also be stated that the young Whimbrels of *both forms* have that part of the plumage spotted and streaked. The western race, from some cause, has become more highly specialized, so that it no longer retains in adult plumage the spots and streaks of its youth; but Natural Selection could not possibly have aided the process. A very similar instance is to be found in the Bar-tailed Godwit (*Limosa rufa*). This is another Palæarctic species which has been divided into two enormous colonies, with the usual result of an eastern and a western form being produced. The lofty mountains and arid deserts of Central Asia present an impassable barrier, so that the winter-quarters of the two races are isolated at the present day, although their breeding-area seems to be continuous. The eastern form, *L. uropygialis*, only differs from its western representative in having

the dark centres of the feathers of the lower back larger and more numerous. In the same way the Black-tailed Godwit (*L. melanurus*) has become segregated into two representative forms; but the eastern race, *L. melanuroides*, does not present any difference in colour, though it is, on an average, slightly smaller in size. The Red-footed Falcon (*Falco vespertinus*) is another of the numerous west Palæarctic species which is represented in the east of that region by a closely allied form. East of Lake Baikal it is replaced by *F. amurensis*, the males of which differ from their western ally in having the under wing-coverts and axillaries white instead of slate-grey. Singularly enough, this latter form breeds as far east as North China, but winters in India and South-east Africa. Many other cases might be given, amongst the most interesting being the eastern and western forms of the Marsh-Harrier, the Common Buzzard, the Song-Thrush, the Little Stint, the Common Tern, and many of the Palæarctic Geese; but sufficient has already been said. I should, however, here remark that I cannot name a single instance amongst the numerous cases of this kind where it can be shown that the differences which the two forms present are of the slightest advantage or can be explained by Natural Selection! The characters by which these eastern forms have been separated are so slight, either of colour or size, that it is impossible to account for them in any other way than by the hypothesis of Isolation.

A few other remarks concerning the results of Isolation on Palæarctic species are necessary. It is a most remarkable and interesting fact that amongst the Palæarctic Ducks there is not a single species with an eastern and a western form. The phenomenon may be explained in this way:—When these

birds were driven southwards by a glacial period they kept entirely to the sea-coasts, and therefore were not subject to so much isolation as birds which obtained their food exclusively from the land. The waters of the Mediterranean, the Red, Black, and Caspian Seas, Indian and West Pacific Oceans, and probably the large lakes of Southern Siberia were open to them, and rendered their area continuous, although they were driven so far from their polar haunts. With Land-birds and Waders a more complete isolation took place, as we have already seen; consequently we find that out of upwards of 550 West Palæarctic species (excluding the Anatinæ), probably eighty per cent. are represented in the East Palæarctic Region by closely allied species or by representative forms, which are only kept from complete differentiation by the interbreeding which takes place in the central districts. It is also another very interesting fact that almost all the West Palæarctic Geese are represented in the eastern portion of that region by closely allied forms. Geese, although so closely allied to Ducks, are land-feeders; hence the probable cause of the differentiation which has taken place through their being isolated. In the Nearctic Region the facts are similar; no eastern and western forms occur amongst the Ducks, but many amongst the Geese. A critical study of the geographical distribution of the Anatidæ seems to show that the Isolation which from time to time has taken place in many species, ultimately causing their differentiation, has been rather in a northern and southern direction than in an eastern and western one. This appears to be proved by the great numbers of representative species that we find isolated in the tropics and the southern hemisphere. Most, if not all, the tropical Ducks are residents, and conse-

quently their wings have become much more rounded than in the migratory northern species *.

The phenomenon of a northern and southern isolation is, however, by no means confined to the Anatidæ; for we find numerous instances of modified tropical forms of northern species resident in the south. Of these, the Little Ringed Plover and its southern form, *Charadrius jerdoni*, in Ceylon, and the Rough-legged Buzzard, with its representative form, *Archibuteo strophiatus*, in Nepal and Thibet, may be given as instances. In the same way many Palæarctic species have become isolated in the south in mountain-ranges, so that we find resident representative forms of many northern species in the Caucasus, the Himalayas, and the mountains of South China. The Palæarctic Region is favourable to this mode of Isolation, owing to the mountains running from east to west; in the Nearctic Region, where they run from north to south, few, if any, cases of a similar nature are known. A glance should also be given at those eastern and western species which have obviously descended at no distant

* Had space permitted, it was my intention to go into considerable detail respecting the distribution of this important family of birds; but I reserve my remarks for a separate publication. There can be little doubt that the Ducks are a polar group of birds; but whether their dispersal has been from the north or south pole, it is difficult at present to say. I am also of opinion that, when the distribution of this group has been more carefully studied, considerable light will be thrown on the cause of the assumption of the brown summer plumage by the males of so many species. This brown dress may very possibly be the last remnant of what was once a regular winter plumage, and the partial moult in summer may eventually be entirely dispensed with, as in the more highly specialized Geese &c. That the brown plumage is not donned for any *protective motive* I am almost convinced.

period from a common North Polar ancestor, but which do not interbreed, although their geographical areas impinge. As a case of this kind, we may mention the Golden Plover (*Charadrius pluvialis*) and its very near ally the Asiatic Golden Plover (*C. fulvus*). The former species breeds in the northern portion of the Palæarctic Region, as far east as the valley of the Yenesay. In this valley it meets with *C. fulvus*, which inhabits the Eastern Palæarctic Region. The differences between the two species, though somewhat slight, are constant. The Nearctic and Palæarctic Teal and Wigeon are other instances. The same remarks apply to several coast-birds that do not breed far north. These eastern and western species are completely isolated on the Atlantic and Pacific coasts of the Palæarctic Region, consequently no intermediate forms are found, and each ranks as a well-defined species. The Oyster-catcher (*Hæmatopus ostralegus*) and the Pacific Oyster-catcher (*H. osculans*) may be cited as a case in point. The latter species only differs from the West Palæarctic Oyster-catcher in having a longer bill, in having the upper tail-coverts tipped with black, and a less amount of white on the quills. The upper tail-coverts are, however, a somewhat variable character—not, I believe, from any interbreeding of the two species, but probably owing to an occasional reversion to those of a common ancestor.

Again, it is interesting to note how many West Palæarctic species find the eastern limit of their distribution in the valley of the Yenesay, whilst many East Palæarctic species find their western limit in that valley. Of the former the Fieldfare (*Turdus pilaris*), and of the latter the Siberian Ground-Thrush (*Geocichla sibirica*) may be quoted as instances. We have other cases of Isolation, even in the

western part of the Palæarctic Region, of closely allied species and representative forms apparently isolated by the Ural Mountains, or, in the case of arboreal species, by the treeless steppes of Eastern Europe; but sufficient has been said on this branch of the subject. It must, however always be borne in mind that the differences between these forms and species can only be accounted for by the Isolation ages ago of individuals of one dominant species in certain localities, and that Darwin's hypothesis concerning the origin of species supplies no explanation to the interesting phenomena. In a word, I believe that much of the complexity of structure, beauty of form, and brilliancy of colour have had their origin in simple variation preserved and developed in certain directions by Isolation.

II.—CLIMATIC INFLUENCES.

In my second division I purpose to deal with Climatic Influences. That climate has been the means of modifying many species no ornithologist will attempt to deny. Any naturalist who has travelled over country subject to considerable diversity of physical conditions is well aware that the different forms of animal life he meets are evidently affected in their colour by the climatic peculiarities of the district in which they reside. In the Arctic regions many of the birds and animals have become completely white, or individuals of many species living in cold climates are decidedly paler than those found in warmer or more pluvial localities. In desert regions the birds and animals are generally of a sandy hue; whilst in wet tropical districts we find many representative forms of northern species with the colours darker and more emphasized. Most, if not all, of this climatic modification has been attributed to the direct influence of Protective or Natural Selection. The suggested explanation of the interesting phenomenon is, that in the struggle for existence to which these forms of life are subject, those individuals that chanced to vary in the direction which rendered them less conspicuous were preserved by Natural Selection, those that did not were ultimately

destroyed. This explanation is a very plausible one, so long as we have only distinct species to deal with ; but when we find every shade of colour, from a brown desert form to a white arctic one, in intermediate localities it seems impossible to account for most of this variation in colour by any protective hypothesis. As another most convincing proof that colour is largely influenced by climate may be mentioned the fact that in Scandinavia we find no extreme arctic forms, such as are found in similar latitudes further to the east, simply because the Gulf-stream makes these latitudes so much milder. Again, we find many arctic forms, or races which are modified by the coldness of the climate, in Siberia, in latitudes as low as in England, merely because the climate is so much colder. At first sight it appears an anomaly that the extreme arctic modification of climatic change of colour should be reached in Kamtschatka, a country situated between the same parallels of latitude as the British Islands. But the student of geographical zoology must bear in mind that no warm currents encircle the coasts of this dreary land, and that the isothermal zone of eternal ground-frost extends throughout this peninsula, there reaching a lower latitude than in any other part of the northern hemisphere. The climate is also very dry, as well as cold, which further aids in the modification of these extreme arctic forms.

There are many cases amongst Palæarctic birds where it is impossible to conceive how the climatic variation in colour they present can be of any advantage to its possessors, and thus have been acquired on the Darwinian theory of Natural Selection. The common British Nuthatch (*Sitta cæsia*) and its various representative forms may be cited as a case in point. The typical form of this bird inhabits Central and

Southern Europe, ranging as far south as Algeria and as far east as West Persia. In Scandinavia and West Russia the pale chestnut on the breast and belly is almost obsolete, though the dark chestnut is retained on the flanks and the margins of the under tail-coverts. This form is known as *S. europæa.* Further east these differences become more marked, and in North Russia, as far east as the Ural Mountains, a slightly larger form occurs, with the chestnut on the underparts much less in extent and with the white parts purer. East of the Ural Mountains, across North Siberia to Lake Baikal, the Nuthatches have the chestnut on the flanks much more reduced and the underparts pure white, whilst the size is smaller; they are known as *S. uralensis.* East of Lake Baikal the extreme arctic form of Nuthatch (*S. albifrons*) is reached in Kamtschatka; much more white is to be found on the plumage, and the small feathers at the base of the bill are white instead of black. The Nuthatches found in the valley of the Amoor, on Askold, and the main island of Japan are known as *S. amurensis*, whilst those inhabiting China have been named *S. sinensis.* Both these latter forms differ but slightly from South-European examples. The Marsh-Tit (*Parus palustris*) and its various forms supply us with similar facts. In warm pluvial regions we find the brown intensified; in dry sandy districts it is lighter; whilst in the arctic regions it is of variable degrees of paleness, until in the rigorous climate of Kamtschatka it is almost white. All these forms of Nuthatch and Marsh-Tit intergrade respectively; the differences are only of subspecific value, owing to the interbreeding which takes place between the several races. The white arctic forms merge insensibly into the brown pluvial forms, and both these into

the forms from dry Central-Asian districts. It is therefore impossible to show how any of these types could have been modified on any Protective hypothesis. The cause of the modification must be sought in another direction; these differences in the colour of the plumage must be ascribed to climatic influence. It must also be borne in mind that the intergradation of colour between many climatic races is not so much the result of interbreeding (as some naturalists suppose), but of the difference of climate in the intervening localities. The Hazel-Grouse (*Tetrao bonasia*) furnishes us with another remarkably good instance of climatic variation. This bird has a very extensive range, being found in suitable localities from the Pyrenees and Scandinavia, throughout Europe and Siberia, to Japan. Birds inhabiting the northern districts, where they are exposed to a dry arctic climate, are very grey in colour; whilst those from the pluvial localities in the mountains of the south (as, for instance, in the Pyrenees, the Alps, Carpathians, the valley of the Amoor, and Japan) are characterized by their rich rufous plumage; in the north the brown is bleached to grey, whilst in the south the rainfall and greater warmth combined have developed it into chestnut. Every intermediate form between the two extremes is to be found in districts subject to an intermediate climate.

It is only amongst *resident* species that we find this modification in colour—species that are constantly exposed to the climatic influences, which finally change the hue of their plumage. Migratory birds come and go in these regions where the climate has produced such marked results amongst their resident cousins. They do not differ from them in any perceptible degree in their habits. All are subject to the same

conditions of life—the same enemies pursue them as hunt their modified allies; why, then, are they not clothed in a similar protective dress? The reason has not far to be sought; their short stay in the region, and consequently brief exposure to the modifying influences of its climate, is not sufficient to affect the colour of their plumage, and, I think, conclusively proves that in many cases climate alone produces a difference in the colour of the feathers, and that they are not so modified by any Protective Selection.

Many desert birds have rich bright colours on their plumage, and these, curiously enough, are in almost all cases principally on the underparts. Among the birds so modified may be mentioned the Coursers (*Cursor*), most of which have the underparts richly marked with black or chestnut. At first this appears to be a convincing proof that Natural Selection has been the means of modifying the upper parts and rendering them inconspicuous, whilst it allowed the underparts to be so gaily adorned; but we must remember that these brilliant plumes are on the under surface of the body, and consequently shielded from the influence of the scorching sun, which has succeeded in modifying the dorsal plumage by the action of its fierce, incessant rays. We may divide climatic influences into three well-defined classes, namely, arctic, tropical, and desert. It is needless to bring forward special examples of each of these classes; but it may be remarked that almost every resident species, whose range extends over regions subject to each and all of these climatic changes, presents differences of colour in accordance with them. Species that are resident in any one of these localities are modified in a similar way, and by this means many new forms are evolved. It is also

a very interesting fact that some colours are much more susceptible to climatic influences than others. Blues, blacks, and slate-greys do not appear to be so sensitive as browns and chestnuts; whilst yellows and reds seem to be but little influenced by any change of climate. Many interesting instances illustrating this fact could be brought forward did space permit.

In many cases, however, it would be rash and illogical to deny the advantage which a species acquires through the colour of its plumage being of a protective nature. I think it is very probable that many resident birds and animals in desert or arctic regions, when they became so modified in colour by the climate in which they lived, sought those places which best harmonized with their colours, to conceal themselves from the prying glance of enemies. We can then understand many protective habits of animals and birds, as, for instance, that of crouching motionless upon the burning sands, conscious that their brown dress is in harmony with the surrounding wastes, or that their pure white garb is inconspicuous amongst the eternal snows. These creatures have not become so changed in colour by any desire or sense of need on their own part, or by Natural Selection weeding out all individuals that did not acquire that change, but simply as an inevitable consequence of their residence in the climate, which alone is the modifying influence. When that change of colour has once been established (and, mind, it was not a *conditional* but an *inevitable* result), we can understand how Natural Selection exerted some influence by weeding out those individuals that did not avail themselves of the best methods of concealment. There can be no doubt that, owing to the remarkable manner in which species adapt

themselves to their surroundings, the colour with which climatic influences have painted them has been utilized in the best possible way for the good and protection of those species. Wallace states that if modifications, though useless at the time they first appeared, became in the highest degree useful at a much later period in the history of a species, "we should then infer the action of mind, foreseeing the future and preparing for it, just as surely as we do when we see the breeder set himself to work with the determination to produce a definite improvement in some cultivated plant or domestic animal." But I do not think we require to assume any such forethought or sense of future need; for we know very well that species are ever displaying marvellous power of adapting themselves to altered conditions of life, and taking advantage of any change that may arise in their favour. We can therefore understand how the modifications which many species have undergone, through climatic and other causes, have been taken advantage of *when they began to be of service*, although at the time the modifications took place they were not of the slightest use!

There is another grave and what seems to me to be an insurmountable difficulty which those who attempt to explain by the aid of Protective Selection this modification in colour which many species have undergone will have to overcome; and that is how the incipient variations were of sufficient use or benefit to protect their fortunate possessors, or to give them such an advantage over their companions as to ensure their ultimate survival. This modification in colour which we now behold must have taken ages to produce—long residence amongst the surroundings, and subject to the conditions which have brought about the change. If the

colour was donned from protective motives, to escape some special enemy, it seems impossible not to believe that the species would have become exterminated long before the protective colour reached a beneficial degree of development. On the theory that climate has been the means of modification no such difficulty arises. We are too prone to look upon a brown desert bird or a white arctic one, now that climatic influence has probably reached the limit of its power in each particular species, as a wonderful example of Protective Selection; but we forget that as the climate wrought the change of hue in the plumage of these birds, they acquired the habits of adapting themselves to their change of dress, and sought such special means of concealment best adapted to that change. In this part of the process of modification I can see no reason why Natural Selection could not afford considerable assistance, by eliminating those individuals that conformed the least closely to their altered conditions of life.

The colour of the plumage of the Willow- and Red Grouse is often brought forward as a wonderful instance of Natural Selection; but its origin can be accounted for without the assistance of any Protective hypothesis. As is well known, the former bird is brown in summer and white in winter; whilst the latter is constantly brown. The two birds are very nearly allied; in fact the Red Grouse may be regarded as an island form of the Willow-Grouse, its chief peculiarity being the absence of any white winter plumage. There can be no doubt that the colour of the common ancestor of these two forms of Grouse was brown, very similar to the Red Grouse of the British Islands—a supposition which is confirmed by the fact that the young in first plumage of the

two races are almost precisely alike. This dominant species of Grouse was probably dispersed over the northern parts of the eastern hemisphere. As the climate changed during the glacial period its influence was stamped on the plumage of the Grouse, and the brown winter dress was slowly changed to a white one. It is a most interesting fact that only the winter plumage of these Grouse was modified. These birds moult twice at least in the year, and it is easy to understand how the intense cold of winter would modify the plumage assumed in autumn, whilst that moulted in spring would remain unchanged in tint because it was never subjected to the winter climate. I am not aware of a single instance of a resident arctic bird that moults twice in the year which does not have a much paler dress after its autumn moult, if not a perfectly white one; and the same may be said of the few resident animals that change their fur twice in the year. Animals and birds that have only one change of fur or feathers are, I think, without exception constantly white, as, for instance, the Snowy Owl, the Arctic Falcons, the Polar Bear, and the American Polar Hare. To return to the Grouse. When that change in the colour of the plumage took place we can understand how the birds took advantage of any benefit they may have derived from the modification of their plumage; and we can see how to a certain extent Natural Selection may have assisted the process when once it had been fairly started by climatic causes. We can account for the presence of the Red Grouse in the British Islands in two ways. Either we can presume that the range of the dominant species and common ancestor of the two forms of Grouse was rendered discontinuous by the separation of our islands from the continent; or we can

suppose that our islands were stocked by a flock of migrating Grouse, driven southwards by the glacial period, or that spread over them as the species passed north again after that period had passed away. In either case Isolation soon and effectually performed the work of differentiation. The Grouse living in the British Islands were subject to a much milder climate than their continental neighbours, and under its mild influence, further aided by Isolation and the law of disuse, appear to have reverted back to a plumage very similar to that of their common ancestor. Again, we can understand that this reversion would in time be of benefit, and would doubtless be aided to some extent by Natural Selection. It would, however, be difficult to understand how a white dress could have originated on any protective hypothesis; for, in the case of the Arctic Falcons, for instance, the young birds do not assume their snow-white plumage until several years after they are born; and hence they are denied all benefit from it at the very time they are inexperienced and most require it. Depend upon it, it is the white dress of the Ptarmigan (modified by climatic influence) that has sent the bird to the snowy wastes and bare mountain-tops, and rigorously keeps it there; not the bird that has assumed by a long process of Natural Selection a white dress to conceal itself in such localities. When the change took place in the colour of the plumage the species was not slow to avail itself of the slightest advantage it could obtain from the modification, and in this Natural Selection would have some influence in weeding out all individuals that did not so adapt themselves to the changed conditions of life.

III.—USE AND DISUSE OF ORGANS.

We now come to another cause of modification which has undoubtedly played a most important part in the evolution of species, and that is the Use and Disuse of Organs. It is an incontestable fact that use strengthens, enlarges, or develops any organ, whilst disuse in a similar way weakens and diminishes it. We require no better proof of this than the powerful wings of the Swallow—a bird that may be said to live in the air—correlated with legs and feet so weak as to be scarcely able to support the body. On the same principle the Penguin has lost the use of its wings entirely through not using them. Owing to that conservation of energy which pervades all Nature, any organ soon loses power, diminishes and degrades, when it is no longer of service and ceases to be kept in constant use. This hypothesis is old enough; it was propounded as a theory by Buffon, by Dr. Erasmus Darwin, by Lamarck, and, possibly, by some of the other old naturalists who had a dim notion of Evolution; but it was soon discarded, probably because it was not accompanied by that overwhelming array of facts which Darwin gave in support of his hypothesis, and which triumphantly carried the theory of Natural Selection over

all obstacles and objections. Lamarck held that "the production of a new organ in an animal body results from any new want or desire it may experience . . . . other wants will lead to other efforts, which in their turn will generate new organs." Although Darwin appears to have been fully aware of this factor in the evolution of species, he did not attach to it the importance which it deserves. This means of modification appears not to be influenced in any way by Natural Selection; it is the inevitable result of direct action in one case, and the want of action in the other, produced by a variety of causes. Nevertheless Natural Selection is inseparably connected with the use and disuse of organs. Natural Selection, as has often been remarked, can only preserve a beneficial variation, it cannot originate it, it is not a cause of variation; on the other hand, the use or disuse of organs is a direct cause of variation, and can furnish Natural Selection with abundance of material to work upon. There is, however, a growing tendency to repose too much on use and disuse as an evolutionistic factor. For instance, Mr. Butler says ('Life and Habit,' p. 261), "Given the power which Lamarck suggested, and Mr. Darwin's mechanism would appear (with the help of memory, as bearing upon reproduction, of continued personality, and hence of inherited habit and of the vanishing tendency of consciousness) to work with perfect ease." But this would leave much to be accounted for; it cannot explain the slight differences between such vast numbers of species, the complete gradations between so many forms of life—a difficulty which has long been felt by biologists, and which can only be explained by simple variation and isolation. It is, however, very difficult to say in many instances whether a species has

been modified through the use or disuse of any of its organs, or whether it has become so modified by the direct influence of Natural Selection. Disuse of any organ may be of benefit to a species, and that organ may become rudimentary or quite useless solely by the aid of Natural Selection. As an instance may be mentioned the many species of Madeira beetles which have the wings in such a degraded condition as to incapacitate their owners from flight. Darwin accounts for this by suggesting that it may have been an *advantage* to these species to lose the power of flight, and thus be less readily blown out to sea and destroyed. Blind cave-haunting animals are another case in point. Darwin suggests that some of these creatures have lost their powers of sight (their eyes being only rudimentary, or concealed, or even quite covered by skin and fur) through the change being of service to them in assisting them to escape the disease which often attacks the eyes of animals living under such conditions. On the other hand, organs may be highly specialized by use, Natural Selection preserving those individuals which possessed the greatest power in employing them for a beneficial purpose. It is sufficient, however, for our purpose to glance at a few instances where Natural Selection appears to have had no influence, and where species have been evolved without the aid of this selective process.

We can understand how, for instance, as soon as a form has become differentiated by Isolation, the differences it presents may probably entail a modification in its habits, and by this means of structure, through the law of Use and Disuse, quite irrespective of Natural Selection. For the sake of argument we will take an imaginary species of Auk, a good flier, inhabiting a district where its wings were of

great service to it, either in aiding it to capture its prey or to elude its enemies. Now let us suppose that a certain number of individuals of this species by some means were isolated from their companions, and, as the species was not migratory, no intercrossing took place between the two colonies. The birds with which we are interested were isolated in a locality where the conditions of life were much easier. No hungry hawks pursued them; food was easier to obtain, and they had little cause for the use of their wings. Slight modifications of colour might now arise, whilst from disuse their wings would in the course of time gradually lose their strength, decrease in size, and eventually leave the isolated colony of Auks in the same flightless condition as the Penguin, the Logger-headed Duck*, and the Great Auk, and, of course, a species quite distinct from the parent form whence they sprung, which may or may not have become extinct. This argument will apply in a precisely opposite direction; in fact I see no reason to prevent it applying in many directions.

Darwin gives a most interesting instance illustrating the present law. He found that the wing-bones of the domestic Duck weighed less, and the leg-bones more, in proportion to the whole skeleton, than do the same bones of the wild Duck —a fact which can be safely attributed to the one bird flying less and walking more than the other. The Common Cross-

* It is a very interesting fact that the young of this bird are able to fly, the power of flight being lost when they reach maturity. This seems to prove that the Logger-headed Duck has only quite recently lost its power of flight, and that the weak wings have not yet been transmitted to the young. In the Pelican and the Great Auk the modification is much older, or the transmission quicker, for the young are as helpless as their parents.

bill and the Parrot Crossbill furnish a very similar instance. These two birds are regarded by most naturalists as distinct species; but there can be little doubt that they are representative forms of one variable species, the chief structural difference being produced by the law of Use and Disuse. The Parrot Crossbill differs from the Common Crossbill in having a perceptibly larger bill, which has most probably been developed by the bird feeding on the hard pine-cones. Birds inhabiting larch and spruce-fir districts do not have such strong, powerful bills as birds from the pine-forests. Such, indeed, is the great variability of the bill of these birds, that Brehm recognized no less than fourteen species of Common and Parrot Crossbills based on this character alone. The Redpoles and the Reed-Buntings are also admirable instances, showing how the use of an organ can specialize it without the assistance of any selective process, inasmuch as the differences in size and strength insensibly intergrade. As further instances may be mentioned the peculiar, short, rounded wing of the vast family of the Timaliidæ (birds which are not migratory) as compared with the long, pointed wings of the Turdidæ (birds which journey far every year to their breeding-grounds), disuse degrading, and use specializing, the wings of each respectively.

IV.—SEXUAL SELECTION.

It remains for us now to glance at Sexual Selection as a means of modification. To Darwin's genius must be ascribed all the merit of the theory of Sexual Selection. Other naturalists may share with him the honours of Natural Selection; but the way in which he accounts for so much that is novel and beautiful in the animal world is strictly his own, and thoroughly Darwinian in its originality and ingeniousness. Nevertheless I do not think that Darwin was aware or cognizant of all the ways in which his brilliant hypothesis might apply; he only applied it as an inevitable result of that lesser conflict in nature—not the struggle for *life*, but the struggle for *wife*! I hope to be able to give a few facts which appear to show how some of this sexual adornment has been acquired without the assistance of sexual rivalry, as well as to show how the results, when dependent upon the law of battle, can have been assisted by other causes. Again, I think that Darwin underrated the value of Sexual Selection, probably because of the great opposition with which it was received by many distinguished naturalists who had adopted the theory of Natural Selection with enthusiasm. Sexual Selection has been regarded by many able men as almost too absurd for serious considera-

tion; still I think too much importance cannot be given to it, and that it plays a wonderful part, a most wonderful and curious part, in the development of some of the most puzzling yet beautiful forms of life. Darwin placed too much confidence in Natural Selection and far too little in Sexual Selection; whilst as regards the latter hypothesis he never seems to have realized the vast importance of Isolation as a cause of so much diversity in sexual adornment—he placed his faith too implicitly in the fickle taste of the female, faith which is, as regards the fair sex, only too often sadly betrayed. Sexual Selection does not depend on taste alone, although it may seem a misnomer to so entitle such a means of modification if *choice* is not the exclusive agent employed. The term Sexual Selection, however, is so well known that it would be unwise to change it; but it must always be borne in mind that it is used in a very broad sense. The wonderful diversity and beauty of sexual ornament owes its origin not so much to combat between rival males and capricious tastes on the part of the females, but to Isolation, which has undoubtedly been the means of preserving many curious variations in this respect. It is a generally admitted fact that secondary sexual characters are highly variable, probably because their variability is not a capital offence, and does not incur the penalty of death, as it so often does with what we may term protective characters. Hence we can see how, if any variation in this respect chances to arise amongst the isolated individuals of a species, it may most probably develop into a fixed and constant character—not by a law of battle and a female's choice (although both may be exerted), but simply because the variation has every chance of being preserved, because free intercrossing is prevented.

In one direction the extreme of sexual beauty seems to have been reached in the Humming-birds ; and the wonderful diversity of male adornment can only be explained by Sexual Selection as understood in the broadest sense of the term—that is, correlated with Isolation and Variation, and possibly with the greater amount of energy most male animals possess. The Duke of Argyll has gone so far as to state "that there is no connection which can be traced or conceived between the splendour of the Humming-birds and any function essential to their life." This statement is as bold as it is illogical, especially when we remember that it was made in the face of Darwin's hypothesis and in the face of that conservatism which is known to pervade all forms of life, which allows so little to be developed aimlessly or in vain. In the course of his remarks on beauty this ambitious scientist has the temerity to say, when speaking of the Humming-birds, that "a crest of topaz is no better in the struggle for existence than a crest of sapphire. A frill ending in spangles of the emerald is no better in the battle of life than a frill ending in spangles of the ruby." This wonderful development of structure and colour he attempts to explain on the principle of "mere ornament and variety of form, and these for their own sake." It may be quite true that not one of these sexual adornments is better than the other ; but their wonderful diversity of hue and form can arise, and most probably has done so, from the isolation of individuals from various causes. The topaz- and sapphire-crested species have probably descended from a common ancestor, through simple variation and isolation, if not by the direct influence of a choice exerted by the females or by sexual rivalry.

Take another instance. There can be little doubt that Sexual Selection has to a large extent been the means of giving to the male Teal (or to a common ancestor, which the Teal has inherited) the sexual adornments that characterize this beautiful little Duck. At one time the Teal was probably circumpolar in its distribution; but when it was driven southwards by a glacial epoch the birds seem to have become isolated in two colonies—one in the Nearctic Region, the other in the Palæarctic Region. The Teals in the former region have become differentiated, the characters on which their specific distinctness rests being chiefly the colour of the sexual ornaments of the male. There can be no reasonable doubt that when these Old- and New-World colonies of Teals were prevented from intercrossing, variations in either of them would be preserved, and finally become constant characters, not by the females exerting a choice in a given direction or by the combat of the males, but simply by Isolation. The same argument which applies to the Teals also applies to the Humming-birds, especially when we know that the latter are remarkably local in their distribution, many of the species being isolated in a curious manner, and that comparatively few species have wide areas of distribution.

It is a remarkable and most interesting fact that we find some of the most novel and curious sexual ornaments amongst birds that have very small areas of distribution; and I think this fact almost absolutely proves that much of the variety and beauty of these adornments have had their origin in simple variations in different directions which have been preserved by Isolation, more especially if the time of reproduction should, from a variety of causes, take place at diffe-

rent times when the parent species was in the act of segregation *. Take, as an instance, the small group of Auks in the North Pacific. Many of these birds display the most grotesque sexual ornaments, curved plumes springing from different parts of the head or hanging in tufts from the ears ; the bill is also modified in many different ways by horny sheaths, which are cast as soon as the breeding-season is over. Again, the Birds of Paradise are noted for the novelty and beauty of their sexual ornaments, no birds in the world excelling them in the wonderful development of plume and brilliancy of colour. These birds are confined to a very small area, and in that area the species are remarkably local, many being isolated on mountain-ranges and on islands. Many Australian birds are remarkable for novelty of sexual ornament, which there assumes certain kinds of development not found in any other part of the world. In the same way the beautiful Sun-birds of the Old World and the Humming-birds of the New World, gay and resplendent with metallic sheen and curious variety of structure, are equally specialized in sexual ornament and remarkably local in their distribution. These ornaments are all peculiar in type, and probably owe their origin to the isolation of individuals of a species ages ago, as much as, or even more than, to sexual rivalry or female taste. The great variability of secondary sexual characters has in a great many cases destroyed all trace of a common origin in the males of the species in many groups of birds ; but fortunately the almost unchanged females furnish an important clue to the affinities of closely-allied species.

* In this way we can see how food-supply, temperature, or many other conditions which affect the season of reproduction, may indirectly assist the work of modification.

In many birds this great difference is only seasonal, the ornaments being assumed about the time of courtship and marriage, and then lost either by a moult or by abrasion as soon as they have fulfilled their purpose. In many groups the males differ remarkably from each other in nuptial dress, but in winter or non-breeding plumage they resemble each other and the females so closely as to make it difficult to determine to what species they belong. Many Grebes, Herons, Waders, Ducks, and Auks might be cited as instances. The amount of fertility which is known to exist amongst so many Ducks or amongst Game Birds (species famous for sexual ornament) when intercrossed is profoundly interesting, and in my opinion goes far to prove that many of the species in either of these great groups respectively are very closely allied indeed (most of the females resembling each other very closely), although they differ so widely in the colour and structure of their sexual ornaments or nuptial plumage. It would be interesting to know whether fertile offspring would be the result of intercrossing in other large groups (as, for instance, in the Humming-birds and Birds of Paradise), where the species are principally characterized by sexual ornament, the females in those groups being remarkably uniform and similar in colour.

In cases where Isolation did not assist the work of Sexual Selection the process of modification may have taken place in the following manner. Take, for instance, the family of Grebes : their sexual ornaments vary in a remarkable degree, and it is easy to conceive how, in the same species, certain females might prefer or be enticed by certain peculiarities some individuals of the opposite sex might display. Let this choice go on for generation after generation, and it is

easy then to see how slight differences may become constant characters and develop into the most novel ornaments through the laws of variation and inheritance. In time a species would be gradually segregated into groups, which, if the choice continued to be exerted in a uniform direction through the constant choice by certain females for certain males until each group loses the power or the inclination to intermarry, would result in the evolution of several closely allied species that may inhabit almost precisely the same area of distribution. Of course we should then naturally expect to find little difference between such species in winter and immature plumage.

On this principle of Isolation we can explain several curious facts relating to the sexual plumage of birds which have long been regarded as anomalies and inexplicable by ornithologists. One of the best instances that I am acquainted with is the extraordinary amount of variation in the plumage of the male Ruff (*Totanns pugnax*). Scarcely two of these males are alike ; every conceivable change seems to have been rung on the colour of their plumage. I think the explanation of the curious fact must be sought in the following way :—Ages ago it is probable that the Ruffs were divided into several closely allied species by sexual selection, probably during a long course of Isolation in Africa, India, and Burma, where they had been driven by a glacial period from their breeding-grounds in the Circumpolar Region. We can then imagine how several distinct types of sexual ornament could have been developed through the absence of intercrossing, possibly assisted by some choice on the part of the females. As the glacial period passed away, the Ruffs migrated north again towards their old home. The time they

had been isolated was not sufficiently long to prevent interbreeding and fertile offspring when the several species or varieties met again in the comparatively restricted area of the north, and the inevitable result was, as we now see, every possible cross between several easily discernible types. The polygamous habits of the birds would assist in hastening the destruction of the several races. That this is the probable explanation of the singular phenomenon is further suggested by the fact that this singular form of Wader is unique in type—it is the only member of its kind, no near allies or representative forms are known to exist. Again, the parts of the plumage of the male which are common to all the varieties resemble very closely those of the female—a fact which further confirms the view that the Ruff at one time was divided into several species which have again become amalgamated.

Wallace suggests "that the normal action of Sexual Selection is to develop colour and beauty in both sexes by the preservation and multiplication of all varieties of colour in either sex which are pleasing to the other;" and that the reason why so many female birds are not so brightly coloured as the males is because showy tints would be injurious by rendering the female conspicuous whilst rearing the young. Darwin, on the other hand, believes that the cause of these gay colours being so rarely transmitted to the female sex is due to subtle and peculiar laws of inheritance which appear to have a strong tendency to transmit any acquired brilliant colour to one sex only. It is very probable that both these statements are true; strong evidence can be obtained in support of them. There are a great many cases in which the females are as richly adorned as the males, where this beauty of plumage

seems to be transmitted, not only to the female, but to the young, as, for instance, in the Kingfishers, the Sheldrakes, Parrots, &c. On the other hand, Wallace has shown how in so many instances a brilliant-coloured male is mated to a dull and sombre female; and in these cases the evidence seems to prove that Natural Selection keeps in check all tendency to a transmission of this brilliant plumage to the female from protective motives. In support of Darwin's statement there are a great many instances where brilliancy of colour is confined to the male sex alone, although there is no apparent reason why Natural Selection should check its transmission to the female, as, for instance, in the Sun-birds (Nectariniidæ) and the Superb Warblers (Maluridæ). Again, it seems to me that many sexual ornaments may be simply the development of a dull pattern of colour still retained in the females. Thus many female Ducks (as, for instance, the Pochard, Tufted Duck, Surf-Scoter, Harlequin Duck, and the Mergansers) have an identical or very similar pattern of colour as the males, which in the latter sex has been developed into ornaments of great beauty or eccentricity, probably by Sexual Selection, aided by the greater vigour &c. most male birds possess. These *patterns* of colour may be the result of inheritance from a common ancestor (seeing that the young birds display them too), which in the male sex alone has been further developed and beautified. We can thus see how many sexual ornaments got their first start—not really by accident, as has generally been supposed (even by Darwin himself), but by sexual development. The foundation of much that is now novel and beautiful in sexual ornament was already laid, the rough material, in many instances, was already to hand: Sexual Selection has built up from this simple

beginning some, at least, of the brilliant nuptial plumes with which many male birds are now adorned. I therefore view the less developed ornaments in many of the species remarkable for their nuptial plumes, not (as Wallace suggests) as being inherited from the males and kept in check by Natural Selection, but as being the peculiarities of a common ancestor; these females are the least-changed descendants of a common and much duller-coloured parent form than the males of the same species, which have obtained increased brilliancy of plume by sexual vigour and rivalry, as understood in its broadest sense. The Woodpeckers furnish us with further examples of this interesting phenomenon, as also do the Birds of Paradise, especially such forms as *Diphyllodes wilsoni*, *Parotia sexpennis*, *Paradisea sanguinea*, and *Ptiloris paradiseus*.

The three species of Golden-eye Duck (*Anas albeola*, *A. islandica*, and *A. glaucion*) appear to illustrate this law in a very interesting manner. All the females of these three Ducks have a nearly uniform brown head and neck in violent contrast to the rest of the plumage, those parts being nearly uniform black in the males. In addition to these characters the female *Anas albeola* has a small white patch on the sides of the head analogous to the large white tuft which adorns the male. All three females have the pattern of colour on the wings very similar to that on the males; whilst the females of *A. islandica* and *A. glaucion* are so nearly alike that even a practised eye can scarcely distinguish one from the other. What is the inference to be drawn from these interesting facts? In the first place it shows us, I think, beyond all doubt, that these three birds are very closely allied, and that these characters are an inheritance from a, by no means remote, common ancestor, of which the females are

the least changed descendants. In the second place, I think it shows that the differentiation of the species is almost entirely due to Sexual Selection (either by Isolation in the past, or by persistent choice by certain females for certain males), which has, to a large extent, worked on the materials already furnished and still retained in the females, by developing and beautifying certain characteristic patterns of colour, which acquired beauty has been transmitted to one sex alone. All these females, it should be remarked, breed in holes ; and therefore it cannot be presumed (as Wallace suggests) that the females are prevented from assuming these brilliant tints by the influence of Natural Selection. Numerous other instances of a similar nature might be brought forward; but sufficient has been said to illustrate this peculiar method in which Sexual Selection has been applied in the great work of Evolution.

Sexual Selection, however, acts in other ways than by developing and accumulating plumage of extraordinary novelty and beauty to please and fascinate the gentle sex, or by developing spurs and other weapons by which the rival male may fight for and win his brides *. This peculiar law of

* It has lately been suggested, in a communication thought sufficiently important to be read before the Zoological Society of London, that spurs and other weapons used in sexual battle were developed, not for the purpose of winning the females, but so that the superabundant males might kill each other, and thus benefit the species !! Speculative hypotheses of this kind are unfortunately too common in natural science, and have well nigh reached the limits of absurdity. In the first place, I think that it is an abundantly proved and generally accepted fact that the males of those species which are noted for their weapons of war are certainly far less numerous than the females (in spite of the evidence brought forward by this wild speculator, whose thirst for novelty seems un-

nature has doubtless been the cause of developing the richness, beauty, and variety of song by which many male birds vie with each other in gaining the affections of the female. It will thus be seen that Sexual Selection exerts its influence on sound as well as on sight; it appeals to the ear as well as to the eye: so that there can be little doubt that the beauty of the woodland concert owes its origin to sexual rivalry in this direction. The love-passion of the Sky-Lark and the Nightingale has given to those birds their wonderful richness, variety, and melody of voice. Birds which are possessed of any considerable powers of song are rarely dressed in attractive colours *; and it is a curious fact that those species which have little or no beauty to display seldom court the female by those curious antics which so many gaily dressed birds indulge in. I think that the song of a bird can be a strong and powerful aid in the modification of species. The notes of birds, like every thing else in Nature, are subject to considerable variety. If certain females are charmed by any peculiarities of plumage or colour in certain males, I can see no reason why the same great law should not apply to vocal sounds as well. If certain females showed preference for

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bounded), hence the practice of polygamy. Secondly, it seems far more logical to presume that, if these weapons are of any other service, they may assist the male bird to beat off those enemies which his brilliant and conspicuous dress is ever liable to attract, or his comparative helplessness (as, for instance, the male Argus Pheasant) prevents him from otherwise escaping.

* It is probable that Natural Selection keeps in check any tendency in these species to become brilliant in colour, as their variety and loudness of song would be still more likely to betray their whereabouts to an enemy if their plumage was conspicuous.

certain males possessing a peculiar variation of song, it is easy to conceive how in time slight structural variations which those individuals might present could be preserved, and in time become constant characters through the absence of intercrossing, just as in those species which may have become modified through certain females showing preference for certain males which displayed any variation of colour that might charm or attract them. That some such choice has been exerted is, I think, proved by such cases as the Willow-Wren and Chiffchaff—two species which are very closely allied, indeed, but which differ remarkably in their *song*! The Marsh- and Reed-Warblers furnish another instance; and Mr. Brooks, the celebrated ornithologist, has informed me that several species of Indian *Phylloscopi* can only be distinguished with certainty by their notes! There may be many other similar cases as yet unknown to naturalists. Again, much diversity of song has been acquired by Isolation. Closely allied forms generally show some difference in their call-notes or their song. In Algeria I was much struck by the different kind of notes which were uttered by several of the birds whose music I had learnt by heart in English woods; and in the groves of Tallisker, in Skye, I remarked that the notes of the Chaffinch were quite different from those heard elsewhere on the mainland of Scotland. This interesting subject is one which has been little studied by naturalists from a Darwinian point of view; yet I feel convinced that it would yield many novel results if it were so investigated.

It is inconceivable to me how, in the face of the overwhelming array of facts which Darwin, in his wonderful book on the 'Descent of Man,' has brought forward to support his theory of Sexual Selection, so many naturalists appear

to doubt the truth of his brilliant hypothesis, although they unreservedly accept the theory of Natural Selection. Those who sneer at Sexual Selection should be prepared to supply us with some other and more plausible explanation of the complex phenomena which that hypothesis has, I venture to say, already so admirably supplied. If most of the sexual beauty in the animal world has not been acquired by Sexual Selection, it is impossible to explain it by Protective or Natural Selection. Such vast numbers of species could never have developed their showy dress by any Natural Selective process. To what other universal law can we then ascribe this wonderful diversity of sexual ornament, if the hypothesis of Sexual Selection must fall? If the brilliant plumage of birds has been acquired on any protective hypothesis, or for any beneficial purpose other than of a sexual nature, why are the females and the young, in the majority of cases, left unmodified, and thus obviously at a disastrous disadvantage? It seems illogical to deny to our blood-relations that love for beauty and that taste for pleasant sounds which we ourselves enjoy, and which has played such an important part in the history of mankind. Tastes, like every thing else in Nature, vary, even amongst civilized man. It is not difficult, then, to see how variation has been made to suit the numberless tastes and choices of all other forms of animal life as well as of the human race.

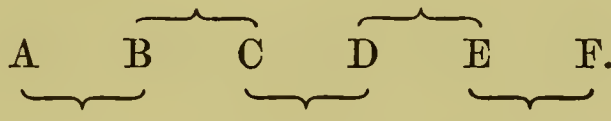
V.—INTERBREEDING OR INTERCROSSING.

It remains now but to briefly glance at a subject which is of the most vital importance in the evolution of species, and that is Interbreeding or Intercrossing. It is very surprising how few naturalists seem to have a clear idea of the scientific meaning of the term "Interbreeding," or are able to comprehend the subject from any but a popular and an erroneous view. Popularly speaking, by the term Interbreeding some such act as the crossing of one distinct species with another is meant—as, for instance, a union between a Horse and an Ass, or a Pheasant and a Domestic Fowl. Such phenomena are, however, exceptional and abnormal, and are vastly different from that Interbreeding (or what, perhaps, might be termed Reciprocal Breeding or Conjugal Reciprocity) which is incessantly taking place amongst all species as well as amongst many closely allied forms of life which are regarded by evolutionists as subspecies only. Interbreeding may be divided into three distinct classes:—A, the interbreeding amongst the individuals of a species, which is quite distinct from cross-breeding; B, the interbreeding which

takes place amongst subspecies, local races, and representative forms; and C, the interbreeding which, by absorbing a closely allied form, gradually works the extinction of a species. As regards the first class (A), the Interbreeding which takes place amongst the individuals of a species: it is by this peculiar form of interbreeding (far better termed Reciprocal Breeding) that the similarity of individuals is retained; it keeps, as Darwin says, "the individuals of the same species or of the same variety true and uniform in character," and prevents universal mongrelization. It is an established fact that so long as all the members of a species can breed freely amongst each other, little or no variation can be produced. The very fact that all the birds of a certain species can breed together is the secret of the species remaining constant in character. This is almost conclusively proved by the fact that as soon as any individuals become isolated from their companions, and are prevented from intermarrying with them, slight variations are preserved; and if the absence of intercrossing continues for any length of time, these variations usually assume a constant character, and by this means many new species are evolved, as has already been shown in the preceding pages.

The second class (B) of Interbreeding is very different. It is that which takes place between two subspecies, as, for instance, between the eastern and western forms of so many Palæarctic birds. The extreme form in the east and the extreme form in the west are, probably, so completely differentiated that they may be physically unable to interbreed and produce fertile offspring. Geographical conditions also prevent any intercrossing between the two extreme forms; but interbreeding can and does take place in the intervening

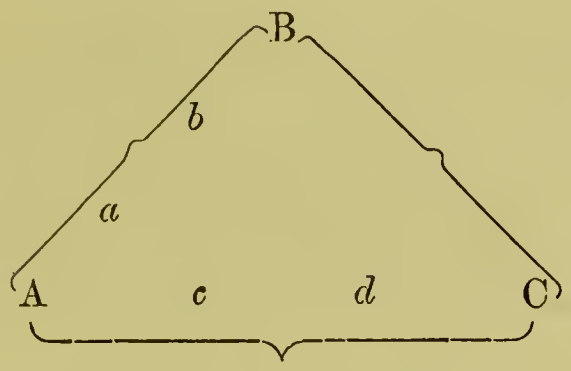
localities. These intermediate forms in many cases probably most closely resemble the common ancestor, which, in spreading in different directions, gradually became modified into the two extremes; but isolation has never been complete (or, if it has taken place, it was not of sufficient duration), and hence the individuals in the intervening area of distribution continue to interbreed in different directions, and thus prevent the complete segregation of the two extreme forms. Or intermediate forms may be caused by the interbreeding of two extreme forms when the areas of distribution become continuous again after a period of isolation. The following diagram will better illustrate these interesting facts :—



Supposing that A and F are two fairly well-defined subspecies, as, for instance, the West and East Palæarctic races of the Curlew (*Numenius arquatus* and *N. lineatus*), B, C, D, and E will represent the various intermediate forms in the intervening localities : B, for argument's sake, those breeding on the tundras of East Russia; C, those in the valley of the Obb; D, those in the valley of the Yenesay; and E, those in the valley of the Lena. Probably no interbreeding takes place between the two extreme forms A and F, or even between B and E; but the individuals represented by A intermarry with those represented by B. B further intercrosses with C, and C with D; D will not only intermarry with C but with E, and E will intermarry with D and F. By this means the points of distinction which characterize A from F will be completely bridged over by the inter-

breeding which takes place in the intervening localities, and a perfect series is produced from one extreme form to the other.

Numerous other instances of a similar nature might be given, amongst them being those of the Dippers, Nuthatches, and Goldfinches; but we will glance at a somewhat more complicated case furnished by the Great Grey Shrike (*Lanius excubitor*) and its allies. Mr. Seebohm (one of the very few ornithologists who has insisted on the importance of interbreeding amongst birds) writes ('Ibis,' 1882, p. 547):— "*Lanius excubitor* inhabits Western Europe: it is an intermediate form between *L. major* of North-eastern Europe and Siberia and *L. leucopterus* of South-eastern Europe and Siberia. A complete series of examples of intermediate forms connecting *L. major* and *L. leucopterus* may be obtained; and yet both species inhabit the same district in Siberia and appear to be specifically distinct, no intermediate forms having been obtained from that country. On the other hand, both the extreme forms appear to be only subspecifically distinct from *L. excubitor*, inasmuch as in North-eastern Europe every intermediate form is found between *L. major* and *L. excubitor*, and in South-eastern Europe every intermediate form is found between *L. excubitor* and *L. leucopterus*. In this case we may assume that *L. excubitor* was the original Shrike from which *L. major* and *L. leucopterus* have varied in opposite directions." These facts may be better illustrated by the following diagram:—

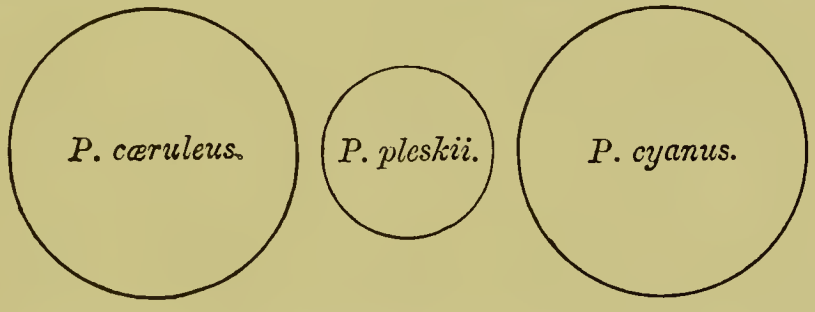


A represents *L. excubitor*, B *L. major*, and C *L. leucopterus*. It will thus be seen that A, on the one hand, interbreeds with B through the intermediate forms *a* and *b*, and, on the other hand, with C through the intermediate forms *c* and *d*; and that B and C are not known to interbreed, or that any intermediate forms are known to occur between them in that part of their distribution, though they are connected together by way of A and the intermediate forms *d*, *c*, *a*, *b*. It is evident that in the case of these birds the two extremes B and C have become so completely differentiated during a period of Isolation that now their areas of distribution are again continuous they have either lost the power or the inclination to interbreed. We can thus see how Interbreeding is the grand check to these three races of Shrike either becoming distinct species, or (as they are evidently in a highly plastic state) being divided into numerous variable races. If it were not for the influence of Interbreeding, the number of existing species of birds would be doubled in a comparatively short time, and this would eventually lead to their complete mongrelization. Interbreeding not only checks the indefinite multiplication of specific forms, but it provides against the extinction of specific characters. A somewhat different kind of Interbreeding is that which takes place between what appear to be perfectly distinct species, as, for

instance, the Hooded and Carrion Crows. Wherever the range of these two species impinges they interbreed and produce fertile offspring, which are not only fertile amongst themselves but with either parent. There can be little doubt that these two species of Crow were evolved by an east and west isolation; but they were not isolated for a sufficient length of time to render intercrossing impossible or unproductive; for when they extended their areas of distribution until they met, they intercrossed at every point where the breeding-areas overlapped. Another somewhat similar instance is presented by the two allies of the common Jackdaw (*Corvus neglectus* and *C. dauricus*), East-Siberian and North-Chinese species.

The third class (C) of Interbreeding is a profoundly interesting one, and appears to have escaped the notice of naturalists until quite recently. To M. Menzbier must be accorded the honour of the discovery of this peculiar form of Interbreeding, which can effect the complete extinction of a species by gradually absorbing it. The subject has been so little investigated that the known instances of this kind of interbreeding are very few; but doubtless it takes place much more frequently than is generally supposed. Its influence in past ages has doubtless been of no small importance in the extinction of many closely-allied species. Only one instance was known to Menzbier, which is that of *Parus pleskii*, a close ally of the Blue Titmouse (*P. cæruleus*). The range of *P. cæruleus* is comparatively restricted, not extending south of the Mediterranean or east of the Ural Mountains. Its eastern representative is the Azure Titmouse (*P. cyanus*), which inhabits East Russia and Siberia as far as the Pacific —a species with the back very pale blue, the head nearly

white, with no black throat or gorget, with no yellow on the breast, and with the white on the outermost tail-feathers largely developed. In Central Russia, between the range of the Blue Titmouse and the Azure Titmouse, a much nearer ally of the former species occurs, *P. pleskii*, having the upper parts about the same colour as the Blue Titmouse; but the yellow on the underparts of that species is replaced in *P. pleskii* by white, except a small yellow patch on the breast. It is shown by Menzbier that the Blue Titmouse on the one side and the Azure Titmouse on the other interbreed with *P. pleskii*, the central form, and are gradually absorbing it by the process. The following diagram will better illustrate the interesting phenomenon :—



It would appear that these three species of Blue Titmouse are modifications of a common parent form by Isolation; but as their areas of distribution again became continuous, the two dominant races have intercrossed with the central form, which is numerically far their inferior and very restricted in its range. The differences developed in this local central form during the period of Isolation are being slowly absorbed by Interbreeding, now that the Isolation has ceased; and the race which would probably have firmly established itself and spread east and west, had it not encountered on either hand a bar to its progress in the two more flourishing, stronger, and wider-ranging forms, is being worsted in the struggle

with them and is slowly but surely passing away. As Menzbier very justly remarks, it would be unfair to presume that this is a solitary case; there are doubtless many others of a similar nature yet to be discovered. Who is to say where it has not acted in the past?—it remains to be shown where it is in progress now*. This peculiar form of Interbreeding appears to me to play a most important and wonderful part in the extinction of species—a part none the less important or wonderful than that which Natural Selection exerts in the same direction, and whose motto is (equally for both) "Let the strongest live and the weakest die."

I think that this peculiar form of Interbreeding will cast some light upon a statement often made by naturalists, to the effect that domestic varieties, when they become feral, slowly but invariably revert to their aboriginal stocks. "Hence," says Darwin, "it has been argued that no deductions can be drawn from domestic races to species in a state of nature." It is most probable that the reversion of domestic varieties to aboriginal stocks, which takes place in many forms, is not due to Reversion in the strict sense of the word, but to the free intercrossing which takes place with their wild companions. As Interbreeding can gradually absorb a subspecific difference amongst animals in a wild state, there can be little doubt that the same will apply to a domestic variety which has become feral and has met

* I can see no reason why it should not take place, although the result may not give any external evidence that such interbreeding is going on. For instance, if a form which is being absorbed by interbreeding only differs slightly in colour from the dominant form which is exterminating it, it is obvious that the offspring of such a union will show little of the results of the cross in their plumage.

and intercrossed with the aboriginal stock whence it originally sprung.

In conclusion, it must always be borne in mind that no amount of Interbreeding, either between two distinct species or between subspecies, can ever result in the establishment of a new specific form*. Intermediate forms, being in some cases probably the least-changed descendants of the common ancestor of the extreme forms of any variable species, and in others the direct result of the intercrossing of the two extreme forms of a variable species (as in the Crows), have always a tendency to die out, and do so as soon as intercrossing ceases. This is the reason why we find so few intermediate forms at the present time between closely allied species; the connecting-links have been absorbed into one or the other of the extreme forms as interbreeding ceased; those variable species that we now behold, which are segregated into two or more local forms, connected by a series of intermediate forms, the result of interbreeding, are but an analogue of what has taken place in the past with so many closely-allied species, and will either become completely differentiated by Isolation or become extinct, just as conditions of life may favour the one or the other end.

* By the vast majority of people Darwin's theory of the Evolution of Species is thought to be nothing else than the crossing of one distinct species with another, the offspring being a new variety or species!! Well may poor Darwin have complained of the load of prejudice with which his hypothesis was overwhelmed!

CONCLUSION.

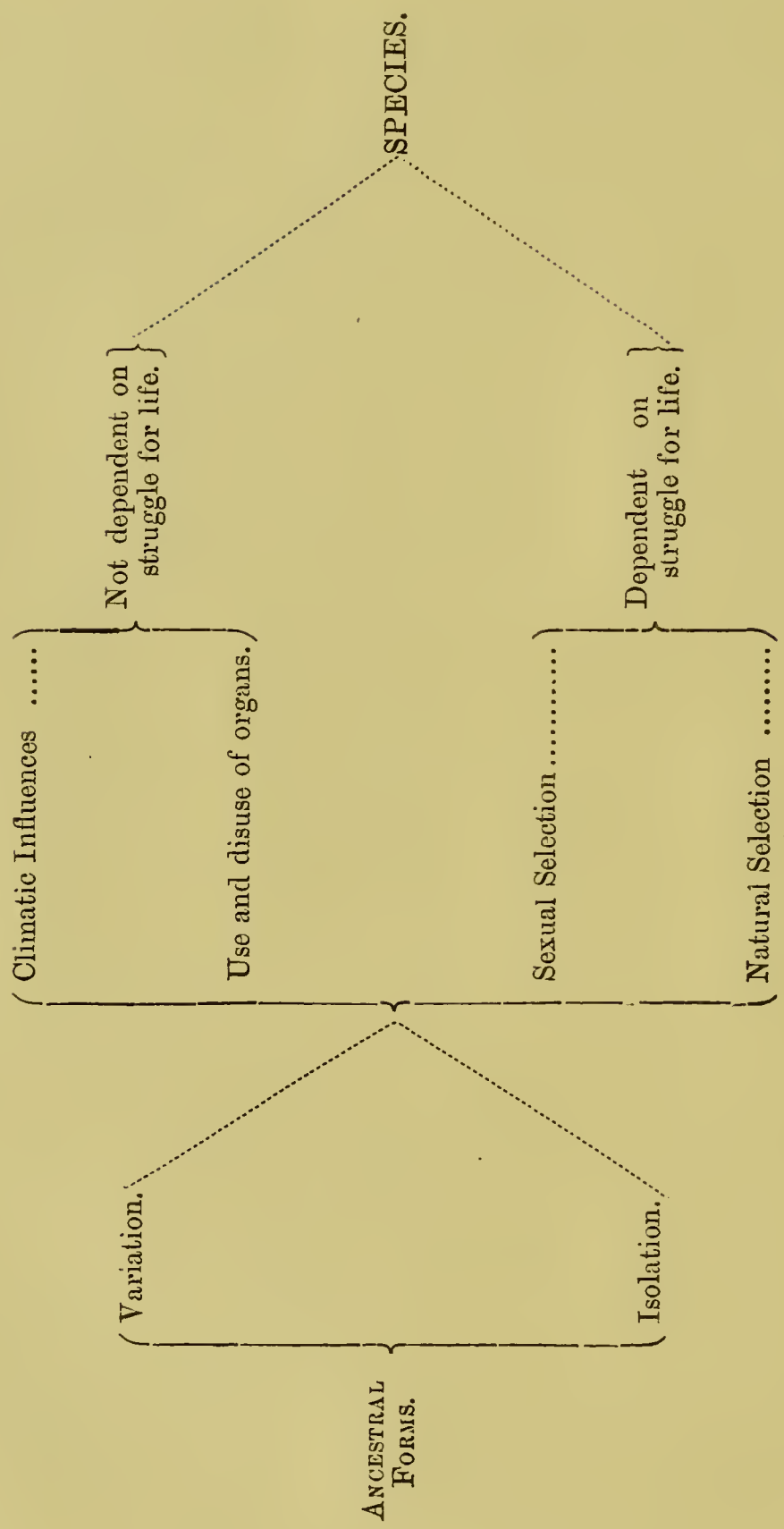
In the preceding pages an attempt has been made to show the importance—the vast importance—of Isolation in the modification of species. Darwin was aware of this factor, but does not regard it with a tithe of the importance which it undoubtedly demands; nor did he (or Wallace either) separate Isolation from Natural Selection. Darwin, in his 'Origin of Species,' says (p. 81):—"Isolation also is an important element in the modification of species *through natural selection*." The italics are mine. Moritz Wagner has published an essay on the subject (which I have not seen), in which he attempts to show "that migration and isolation are necessary elements for the formation of new species." Without going so far as this, I fully believe that the evidence we are able to gather bearing on the subject is sufficient to show the vast importance of Isolation in the modification of many forms of life, without the assistance of Natural Selection. I venture to think that no unbiassed person will be of a different opinion after reading the above scraps of evidence, which are but a tithe of what might have been offered had space permitted.

We must also look back to the past. If these causes are producing such modifications in comparatively recent times (and are now in operation), it is only fair to assume that they have had considerable influence in past ages. Thus there can

be little doubt that many closely allied but perfectly distinct species (say in the Anatidæ, the Laridæ, or Scolopacidæ) were originally modified by some of these causes. At the present time many of the species in each of these great groups inhabit the same geographical area, but have long ago lost the power or the inclination to interbreed and to produce fertile offspring. During the time they were isolated from each other, ages ago, they became sufficiently differentiated, so that now they have come together again they do so as perfectly distinct species, not only with modified colours and, in some cases, structures, but with modified notes and modified habits, developed during the time they lived in the area in which they chanced formerly to be isolated.

Again, I think that chemical influences have been too little studied or taken into account as powerful agents in the modification of species. We know that the nature of the soil will affect many plants to a wonderful degree, and that food has considerable influence in producing changes of colour and possibly of internal structure, which, through the mysterious laws of correlation, might lead to many great and important changes in an organism. It seems to me that chemical influences have played a great part in producing much diversity of colour in organic nature, and that the study of Biology from such a standpoint would lead to important results.

It will be seen that, in demonstrating what I believe to be some of those laws which govern the origin of species, I have confined my remarks almost exclusively to birds. From a brief study of other branches of Natural History (Entomology and Botany), I am, however, convinced that the same general principles will apply to every other form of life (except, perhaps, the lowest organisms), even Man


SPECIES.
Not dependent on struggle for life.
Dependent on struggle for life.
Climatic Influences .....
Use and disuse of organs.
Sexual Selection .....
Natural Selection .....
Variation.
Isolation.
Ancestral Forms.

included! A thorough knowledge of the subject, such as only a specialist can attain, is required in applying these laws to other orders of animal life; and that is the only reason why I have not attempted to apply these laws to any other branches of Natural History. The specialist can demonstrate those natural laws, by the group which is the object of his careful study, far better than the naturalist of only general knowledge, who has so often to rely upon evidence which, if not absolutely untrue, is certainly liable to lead him into the gravest errors.

The Origin of Species may be briefly illustrated by the opposite diagram.

Many of the instances brought forward in the present essay have been taken from representative forms which have not yet succeeded in becoming perfectly segregated species. Many of them are only subspecies. But such are the facts before us at the present day; such, I believe, are some of the means by which species are being slowly evolved around us. What is taking place to-day is but a stage of that grand march which organic life is taking; similar stages have taken place in the past, and will just as surely take place in the future. Birds that are now only subspecies, local forms, climatic varieties, isolated races (call them what we may), will, as future ages roll away, become species or again be amalgamated, or perhaps become extinct, just as conditions of life may favour one or the other end. Let it be clearly understood that not one single syllable in the foregoing pages has been written antagonistic to Darwin's theory of Natural Selection. All I have done has been to attempt to explain certain phenomena which the Darwinian hypothesis can never do, and which its supporters ought never to have attempted to make it explain. Darwin himself, with the

characteristic noble candour which marks his works, admits these difficulties; I have tried to afford an explanation to some of them. The more one studies Darwin's works, the more one is convinced of the truth of his hypothesis (although it may not be universal in its influence) and the superiority of his talents as a naturalist over those of every other the world has yet produced. Darwin laid the foundation of that new method of scientific inquiry which has already yielded such priceless fruit. It was his glorious discoveries that gave to Natural History a new impetus, and infused it with new life and vigour at a time when almost every branch of science was retarded by pedantry and lay languishing in the lap of ignorance and bigotry. Unfortunately there are men who, by far-fetched ridicule and third-rate wit, seek to detract from the merit of Darwin's brilliant discoveries—men who possess but little scientific knowledge themselves and are astoundingly ignorant of the very rudiments of the theory they so glibly criticise and so unjustly condemn. Some naturalists seem to think that with Darwin's great discovery all scientific research has ended. Never was there a greater fallacy. Natural Science is as yet in comparative darkness; but the dawn of Progress lights the eastern horizon, and the careful worker in what I may term the by-paths of Biology, aided by its ever-increasing light, will be rewarded by results of which we now dare scarcely dream.

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